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Investigate Hard Spots in Aluminum

Causes of These Spots in Aluminum-alloy Sand Castings Found To Be Metallic and Nonmetallic Inclusions—The Former Are Due To Admixtures of Iron—Carelessness Largely Accounts for the Latter

BY ROBERT J. ANDERSON AND JULIAN H. CAPPS

INCLUSIONS in aluminum hitherto have not been discussed in the literature, although much has been written with regard to inclusions in iron and steel, and a few scattered papers have appeared dealing with nonmetallic inclusions in brass and bronze. In aluminum-foundry parlance, various kinds of metallic and nonmetallic inclusions are referred to as *hard spots*. This defect in aluminum-alloy sand castings, and in die castings, is exceedingly troublesome. These inclusions are so widely different in character that the term *hard spots* is only roughly descriptive at best. As a matter of fact, this term is an undesirable one, and it should not be accorded acceptance of metallographic nomenclature. However, since it is firmly fixed in foundry parlance and has been in common usage for many years, it will be used in this article to include all metallic and nonmetallic inclusions.

Ordinarily, hard spots in aluminum-alloy sand castings are not found during the routine inspection of rough castings in the foundry, but they usually appear on machining or polishing the castings. The presence of hard inclusions can give rise to much difficulty while machining or polishing, and this defect may be one of the principal causes of machine-shop scrap to say nothing of ruined milling cutters, dulled lathe tools and drills, and irritation to machine operators.

Certain kinds of large inclusions may be noticed in the foundry on removing gates at the band saw or the sprue cutter, or on chipping and grinding the castings, but small inclusions generally are revealed only on machining or polishing. The presence of large inclusions greater than microscopic size readily can be detected in the foundry by examining fractures of the gates. Normally, if inclusions are found in the gates, they will also be found in the castings. This serves as a useful foundry test for detecting the presence of hard spots. Complaints as to the occurrence of hard inclusions in aluminum-alloy castings generally originate in the machine shop. From the machine shop standpoint it is essential that no hard inclusions be present in castings which must be machined or polished. Castings are often returned by machine shops to foundries as scrap because they cannot be machined. Consequently it is highly desirable that methods for the prevention of hard spots be employed, because of the financial losses sustained by the return of such castings to the makers.

Various kinds of hard spots in aluminum-alloy castings are recognized. Such inclusions can be divided into two classes: nonmetallic hard spots, and metallic hard spots. The present article gives in a brief way the results and conclusions from an investigation made by

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FIG. 1—CHUNK OF BRICK TRAPPED IN GATE; ACTUAL SIZE. FIG. 2—CHUNK OF CRUCIBLE IN GATE; MAGNIFIED 2 DIA. FIG. 3—PIECE OF STONE IN GATE; MAGNIFIED 2 DIA.

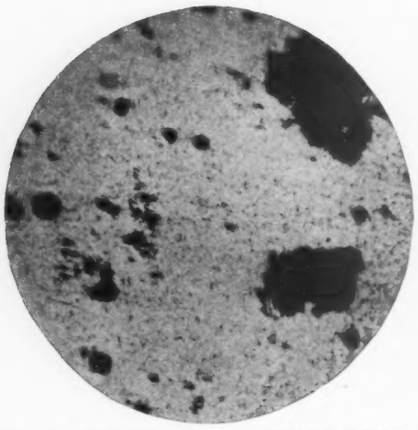


FIG. 4—STONY HARD SPOTS IN VACUUM-CLEANER FAN; UNETCHED; VERTICAL ILLUMINATION; MAGNIFIED 7 DIA.

the bureau of mines for the purpose of determining the causes for the occurrence of hard inclusions in sand castings and suggesting methods of prevention. This investigation was carried out in connection with a general study of casting losses in aluminum founding.

Nonmetallic Hard Spots

Under the heading of nonmetallic there are included all hard, foreign, nonmetallic inclusions, such as pieces of brick, cement, chunks of crucibles, core sand and molding sand, hard clay and the like. These materials cannot get in the castings unless they are charged into the melting pots or allowed to fall into the pouring ladles, and normally they cannot be associated with the original melting stock. Nonmetallic hard spots vary in size from microscopic particles up to chunks 0.5-inch cube and larger. Typical examples of nonmetallic hard spots found in aluminum-alloy castings are shown in Figs. 1 to 11 inclusive. Figs. 1, 2 and 3 show various large nonmetallic inclusions uncovered while sawing off gates from various castings of No. 12 alloy. Fig. 1 shows a chunk of brick trapped in a gate cut from a crankcase; Fig. 2, a piece of plumbago crucible trapped in a gate from a vacuum-cleaner casting; Fig. 3, a piece of stone in a gate from a vacuum-cleaner nozzle. The magnifications given indicate the size of these inclusions. When such large nonmetallic inclusions occur in the gates, they are likely to be struck by the band saw or sprue-cutter knife, and if so, these tools may be broken or at least dulled. When such large inclusions occur in the actual castings, they may be struck by a cutting tool on machining, in which case the edge of the tool will be broken off or turned over.

It is more desirable that the inclusions occur in the gates rather than in the castings, but ordinarily, if they are found in the gates, they are also found in the castings. However, large nonmetallic inclusions, such as those shown in Figs. 1, 2, 3 and 4, are not nearly so numerous as similar small inclusions, and the latter are likely to give more trouble on machining. When large inclusions are present, they are likely to be few in number, but small inclusions have a tendency to be very numerous when they are present at all.

FIG. 6—MICROSTRUCTURE OF ONE OF THE HARD SPOTS IN FIG. 5; UNETCHED; MAGNIFIED 70 DIA.

Fig. 5 is a micrograph showing some fairly large stoney hard spots in a vacuum-cleaner fan, while Fig. 6 shows some inclusions of bits of crucible in the same samples. The dark areas are the inclusions. Figs. 7 and 8 are micrographs showing the structures of the inclusions at higher magnifications. Fig. 9 is an illustration of a polished casting, and it shows a large included piece of crucible which had been brought to the surface on polishing. Fig. 10 is a micrograph of a section cut from a casting which gave great difficulty on machining. Attempts to machine this particular casting were finally abandoned, and the casting was scrapped. The black areas in Fig. 10 are inclusions of sand and bits of plumbago crucible. Fig. 10 shows the microstructure of one of the small inclusions in Fig. 9. In Fig. 11 there is shown a hard, stony inclusion in a section cut from an aluminum-alloy sand casting which gave difficulty in machining. Fig. 12 indicates a stony inclusion in an aluminum-base die-casting. This illustration is interesting as it shows a section containing both metallic and nonmetallic inclusions. The large black area is a stony hard spot, and the small black needles are the iron-aluminum compound, $FeAl_3$. Fig. 13 shows the microstructure of the stony spot; the black area is the included stone; the white areas are the aluminum-alloy matrix, and the white needles are the compound $FeAl_3$.

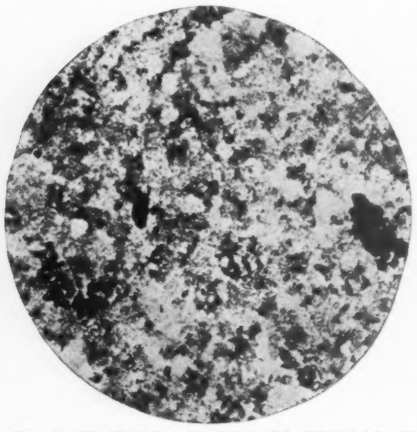


FIG. 5—INCLUSIONS OF BITS OF CRUCIBLE IN VACUUM-CLEANER FAN; ETCHED WITH NaOH; OBLIQUE ILLUMINATION; MAGNIFIED 7 DIA.

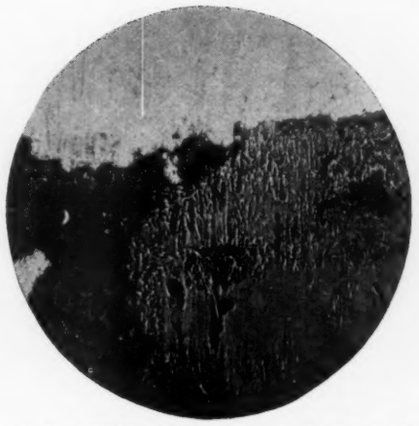


FIG. 7—MICROSTRUCTURE OF ONE OF THE HARD SPOTS IN FIG. 5; UNETCHED; MAGNIFIED 140 DIA.

Metallic Hard Spots

In dealing with the characteristics of metallic hard spots, it is to be recalled that so-called inclusions of the iron-aluminum compound $FeAl_3$ in No. 12 alloy (about 92 per cent aluminum and 8 per cent copper) high in iron, say over 2 per cent iron, is due simply to the fact that this constituent, when present in a ternary aluminum-copper-iron alloy, is insoluble in aluminum in the solid state. Loosely speaking, however, it may be said that so-called metallic hard spots are generally due to iron. Thus the iron may be so high in No. 12 alloy that large crystals of the iron-aluminum

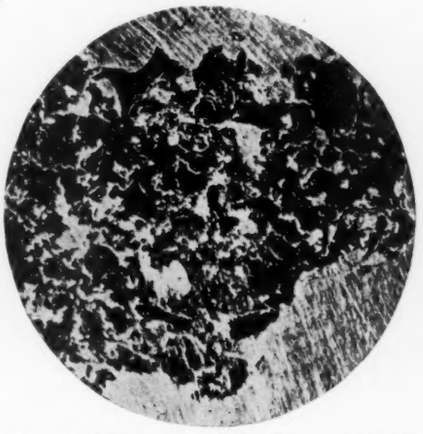


FIG. 8—CHUNK OF CRUCIBLE IN POLISHED CASTING; OBLIQUE ILLUMINATION; MAGNIFIED ABOUT 4 DIA.

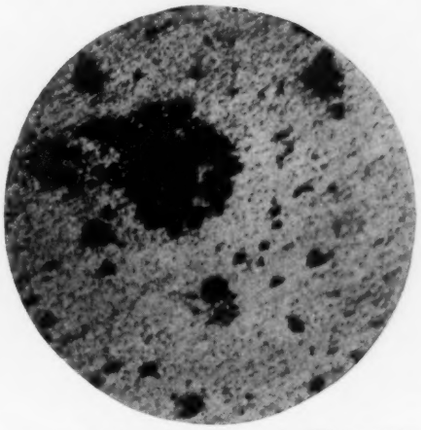


FIG. 9—HARD SPOTS IN A CASTING WHICH GAVE GREAT DIFFICULTY ON MACHINING; UNETCHED; VERTICAL ILLUMINATION; MAGNIFIED 7 DIA.

compound, $FeAl_3$, will be formed. This compound is hard and brittle, and when the iron exceeds 2 per cent, difficulty may be experienced on machining, and it usually will be experienced on polishing. Actual iron spots (true inclusions) may arise from charging nails, core wire, iron chaplets, chills, or other particles of iron with the foundry scrap.

If the melting is rapid, such iron may not be completely dissolved, with the resultant formation of $FeAl_3$, but may remain as solid iron in the liquid alloy. In the final casting, these actual pieces of iron may appear and be shown under the microscope to be iron or steel. Moreover, in the event that pieces of the hard complex iron-aluminum alloy (scale) formed on the sides of cast-iron melting pots are knocked off into the melt on stirring or ladling, actual inclusions of this scale may appear in the castings. Hence, it is advisable to distinguish clearly between so-called hard spots which are definitely known to be $FeAl_3$ and actual inclusions of iron or pot scale. The distinction can be most readily shown by micrographs.

Figs. 14, 16 and 17 were taken from a section cut from an aluminum-base die casting, high in iron, which gave much difficulty on both machining and polishing. Fig. 15 shows crystals and needles of $FeAl_3$ embedded in the alloy matrix, and Figs. 14, 16 and 17 show the various aspects of the compound at higher magnifications. Figs. 18 to 21 inclusive are photographs taken on a section cut from a die-cast spark quadrant which gave great difficulty on polishing. The alloy from which the spark quadrant was cast contained 3.40 per cent iron, 6.25 per cent copper, 0.45 per cent silicon, 0.03 per cent manganese, and remainder aluminum. On polishing the finished castings after grinding, streaks and hard spots appeared on the surface, giving an undesirable appearance. The difficulty was plainly due to the high iron content of the alloy. The softer matrix was worn away by the polishing leaving the hard $FeAl_3$ standing up in relief, thus giving a roughened, streaky appearance to the polished surface.

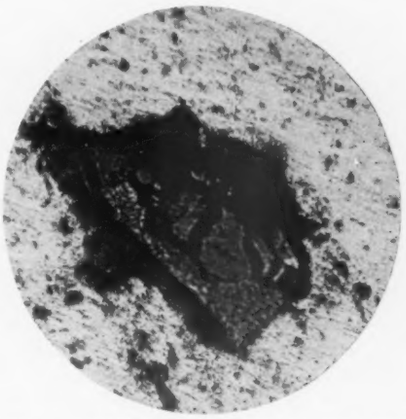


FIG. 11—MICROSTRUCTURE OF HARD INCLUSION IN A SAND CASTING; UNETCHED; MAGNIFIED 130 DIA.

Inclusions of the hard, brittle, complex iron-aluminum alloy (iron pot scale) formed on the sides of cast-iron melting pots are shown in Figs. 22 and 23. Fig. 22 is a micrograph showing large inclusions of the brittle scale included in No. 12 alloy, and Fig. 23 shows the microstructure of one of the large inclusions shown in Fig. 22. The white areas in Fig. 23 correspond to the white specks in the inclusions in Fig. 22. These areas are $FeAl_3$.

FIG. 10—MICROSTRUCTURE OF ONE OF THE SMALL INCLUSIONS IN FIG. 9; UNETCHED; MAGNIFIED 100 DIA.

Nonmetallic Hard Spots

The essential cause for the occurrence of actual nonmetallic foreign inclusions in aluminum-alloy castings lies in charging foreign material into the melting furnace. In some cases, new iron pots may cause hard spots because of the sand and scale adhering to the pots as they come from the foundry. Inclusions from this cause alone will disappear after the pots have been in use for a short time. As previously stated, nonmetallic hard spots may consist of pieces of brick, stone, chunks of cement, pieces of crucibles, small particles of core sand and molding sand, and other extraneous substances which may be charged into the melting pots. These foreign materials are likely to be numerous in foundry-floor sweepings, and nonmetallic hard spots are more likely to be numerous when running on all-scrap or high-scrap charges than when using all virgin melting stock. Occasionally, hard spots may present themselves where surface sand is found in a casting. This is due to incorrect gating, or to too rapid pouring, or both. Under such circumstances, sand from the mold may be eroded by the washing stream of metal and carried into the casting. On machining, such surface sand might give difficulty and cause dulling of the cutting edges of machine tools. Briefly, nonmetallic hard spots are caused normally by charging foreign matter into the melts, and if such foreign materials are kept out of the melting furnace they cannot get into the castings.

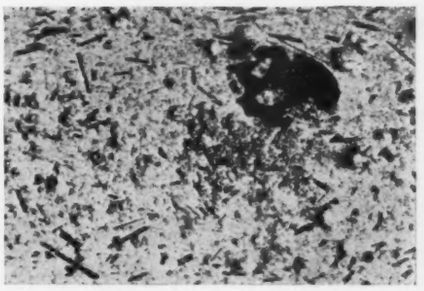


FIG. 12—NONMETALLIC AND METALLIC INCLUSIONS IN A DIE CASTING; ETCHED WITH NaOH; OBLIQUE ILLUMINATION; MAGNIFIED ABOUT 8 DIA.

The distinction between actual metallic inclusions and the presence of the hard iron-aluminum compound, $FeAl_3$, has already been given. However, in foundry practice, it may be said that hard spots caused by iron may be due to four causes: First, to the use of secondary aluminum ingot and secondary aluminum-alloy ingot, high in iron;

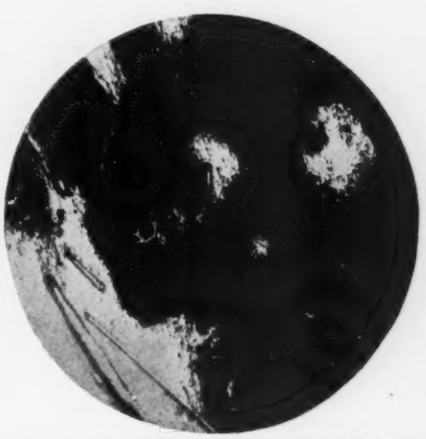
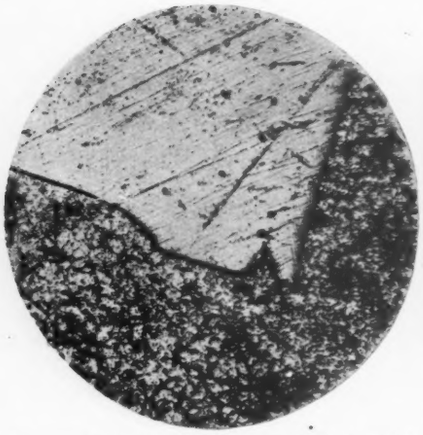


FIG. 13—MICROSTRUCTURE OF THE STONY INCLUSION IN FIG. 12; WHITE NEEDLES, $FeAl_3$; UNETCHED; MAGNIFIED 30 DIA.



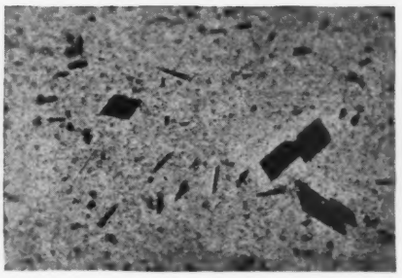


FIG. 14—$FeAl_3$ IN UNETCHED SECTION; SAME SAMPLE AS FIG. 15; MAGNIFIED 30 DIA. FIG. 15—CRYSTALS OF $FeAl_3$ IN ALUMINUM-BASE DIE CASTING WHICH POLISHED POORLY; ETCHED WITH NaOH; OBLIQUE ILLUMINATION; MAGNIFIED 8 DIA. FG. 16—FEATHER OF $FeAl_3$ (WHITE) EMBEDDED IN ALUMINUM-ALLOY MATRIX (DARK); ETCHED WITH NaOH; MAGNIFIED 150 DIA.

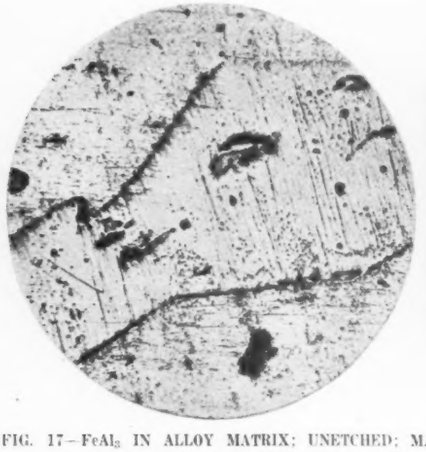
second, to pieces of iron such as nails, chills, core wire, steel chips, drillings and the like, which are charged with the foundry scrap; third, to dissolution of iron from the pots in iron-pot melting; and, fourth, to the hard, brittle, complex iron-aluminum alloy which forms on the sides of iron pots. As to the first, secondary ingot can readily cause the occurrence of $FeAl_3$ hard spots because of the original high iron content of such ingot. Ordinarily, secondary ingot, high in iron, will not be employed for castings made to specifications for the automotive industry, and rarely, if ever, for vacuum cleaner and other castings which must be highly polished. Secondary ingot should not be discriminated against *per se*, but chemical analysis of such ingot should invariably be made. Normally, secondary ingot is not used much for die-castings. However, it may cause $FeAl_3$ hard spots when used for any kind of castings if the iron is over 2 per cent.

Hard spots caused by iron from nails, core wire, chills, and other bits of iron and steel result because this foreign iron is charged with the scrap. When actual iron or steel is charged into an aluminum-alloy melt, for example No. 12 alloy, the iron will go into solution in the aluminum in the liquid state, if enough time is available. The rate of diffusion of solid iron in liquid aluminum is governed by time, temperature and other factors, precisely as in the case of copper in aluminum. Iron forms with aluminum the iron-aluminum compound $FeAl_3$, soluble in aluminum in the liquid state but practically insoluble in the solid state. On freezing, the $FeAl_3$ will freeze independently of the matrix in the form of needles and crystals—hard and white, and readily identifiable under the microscope. In case the iron or steel charged into the melting pots does not have sufficient time to go into solution in the aluminum, it will remain as actual iron included in the resultant castings. From the shape of the inclusions, it may be possible to determine the original form of the iron, for example a nail or a piece of core wire.

Iron Content is Low

Iron dissolved from cast-iron melting pots normally forms the iron-aluminum compound $FeAl_3$. The dissolution of iron is not rapid under ordinary melting conditions, and the iron content of alloys made from primary melting stock is normally low unless the heats have been held in the pot for a relatively long time and at a high temperature during melting. Metal melted in a crucible or in reverberatory furnaces lined with firebrick never contains hard spots from iron unless actual iron has been charged or the iron content of the melting stock is high. With regard to the fourth cause given for hard spots; when aluminum or its light alloys is maintained in the liquid state in a cast-iron melting pot, a complex ferroaluminum alloy is formed on the inside of the pot. This alloy adheres to the sides of the pot, but pieces of it may be knocked off into the pot upon ladling or stirring the melt. Hard spots due to this cause do not appear when melting in a new iron pot because none of the hard complex alloy (iron-pot scale) has yet formed; but when melting in an old pot which has been run for a number of days without cleaning and scraping, hard spots in castings due to this cause may be numerous.

Hard spots are presumed to be more numerous in small castings than in large ones, but there is no basis in fact for this belief. The apparent predominance of hard spots in small castings may be explained on the ground that small cast-



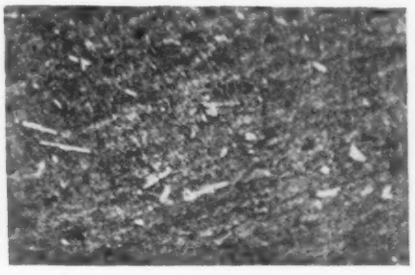


FIG. 17—$FeAl_3$ IN ALLOY MATRIX; UNETCHED; MAGNIFIED 150 DIA. FIG. 18—$FeAl_3$ NEEDLES* IN A DIE-CAST ALUMINUM ALLOY; ETCHED WITH NaOH; VERTICAL ILLUMINATION; MAGNIFIED 8 DIA. FIG. 19—FEATHER OF $FeAl_3$ IN SAME SECTION AS FIG. 18; ETCHED WTH NaOH; MAGNIFIED 30 DIA.

FIG. 20—$FeAl_3$ CRYSTALS IN SAME SECTION AS FIG. 18; ETCHED WITH 20 PER CENT HNO_3; MAGNIFIED 200 DIA.

ings are more generally polished than are large castings. It has been stated that hard spots are not generally found in the routine foundry inspection of castings, but they are revealed during machining and polishing. Hence, if a given casting requires much machining, complaints by the machine shop regarding hard spots are likely to be more numerous than where little machining is done. In the same way, castings which require polishing are likely to show hard spots on the polished surfaces. The method of molding is a factor governing the occurrence of hard spots to a subordinate extent. Skim gates have been suggested and used for the prevention of this defect. While these gates may be of some value in eliminating large included particles, their use is out of the question for small castings, and they will not keep small particles out of the castings.

Blind Risers Useless

Shrink balls and blind risers also have been suggested and used for hard-spot prevention, but these devices cannot be of any value for this purpose. Their use, in this connection, is based on the idea that foreign occluded matter will conveniently rise in the blind riser, but this is patently not founded on fact. Some of the occluded matter is of practically the same density as the aluminum alloy, and some of it may be of greater density. Such material remains more or less fixed in position, wherever it happens to be. The gating of castings is important and has a distinct effect upon the occurrence of hard spots. If there is a sharp constriction in a runner leading from a main gate to the casting, large foreign particles may be trapped in the constricted area and prevented from entering the casting. On the other hand, if such a constriction is at the point where the runner joins the casting, the trapped inclusions will be frozen partly in the runner and partly in the castings. By examining the method of gating and molding, a foundryman readily will be able to determine whether any feature here may be corrected.

The effect of the method of melting has been alluded to above in discussing the causes of hard spots. Iron-pot melting presents some disadvantages, when considered in relation to the occurrence of hard spots, which the other methods do not have. Whereas, hard spots due to foreign materials charged may occur in any method of melting, the iron pot has the disadvantage that not only may iron be dissolved but chunks of the hard iron-aluminum alloy (iron-pot scale) may be knocked off into

FIG. 21—$FeAl_3$ CRYSTALS IN SAME SECTION AS FIG. 18; ETCHED WITH NaOH; MAGNIFIED 200 DIA.

the melt. In crucible melting, if old worn crucibles are employed, pieces of the crucibles may be readily knocked off into the melt on lifting, stirring or pouring. Melting in open-flame, brick-lined furnaces, or in reverberatory fur-

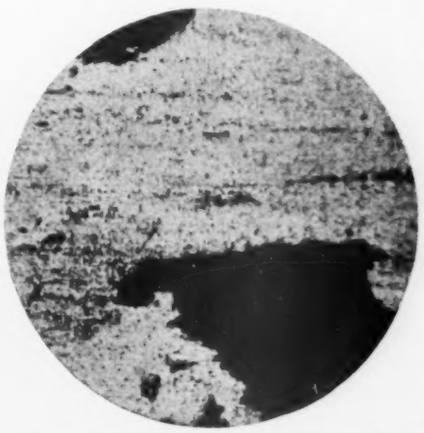


FIG. 22—INCLUSIONS OF IRON-POT SCALE IN NO. 12 ALLOY; UNETCHED; VERTICAL ILLUMINATION

naces has no relation to the occurrence of hard spots, unless pieces of brick may be knocked off into the melt. The effect of the quality of the melting stock has also been alluded to in discussing the causes of hard spots. Castings

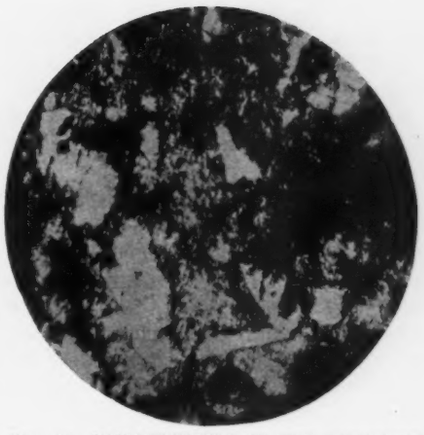


FIG. 23—MICROSTRUCTURE OF THE INCLUSIONS OF SCALE IN FIG 22; $FeAl_3$, WHITE; UNETCHED; MAGNIFIED 100 DIA.

poured from virgin melting materials are less likely to contain foreign included matter or crystals of $FeAl_3$ than castings similarly poured and melted from charges containing much or little scrap. Scrap *per se* is not necessarily conducive to the occurrence of hard spots in the resultant castings, but the trouble arises because foreign matter is more likely to be introduced with the scrap than with virgin melting stock. Hence, it may be stated that the greater percentage of scrap in the charge the more likelihood is there that hard spots will be found in the castings. Generally speaking, hard spots are more likely to be more predominant in foundries where the production is rushed than where a moderate rate of production obtains. This follows solely because of increased carelessness under the strain of rapid work.

Methods for Prevention

In considering the effect of the occurrence of so-called hard spots in aluminum-alloy castings upon casting losses in foundry practice, it is advisable to recall that a not inconsiderable percentage of the castings returned from the machine shop may be rejected because of this defect. By careful attention to certain aspects of foundry practice, the occurrence of hard spots, which give difficulty on machining, may be substantially prevented. Hard spots due to foreign matter, other than iron, originate in the foundry, and they can be prevented by not allowing such materials to get into the melting furnace. In cleaning the melting room and foundry floor for the purpose of gathering up small pieces of metal, sloppings, over-runs and the like, dirt, gravel, sand, cement, pieces of brick, chunks of broken crucibles, etc., are swept up. Unless these floor sweepings are sieved and forked, such foreign materials are liable to be charged into the melting furnace. The presence of foreign materials in the melting charge largely can be eliminated

by carefully watching what goes into the furnaces. Carelessness is the main cause for the presence of such foreign materials, but under the conditions brought about by fast practice, the requisite care cannot always be given to the metal.

All foundry scrap should be forked before charging, and floor sweepings should be sieved. Some of the foreign material, which is inadvertently charged into the furnace, may be removed by skimming and fluxing, but it is not safe to rely upon these precautions to overcome the evils of a dirty charge. No core sand should be left in the defective castings which are remelted, as the hard fine silica particles may give rise to small hard spots. Foreign non-metallic hard spots can be largely eliminated provided sufficient attention is given to the charging practice. The so-called hard spots which are caused directly or indirectly by iron can be eliminated provided suitable simple precautions are taken. Difficulties as governed by the use of secondary ingot or scrap castings purchased from outside sources, can be readily prevented by control through chemical analysis. Hard spots caused by charging nails, core wire, chills and bits of iron and steel can be prevented by careful attention to the quality of the melting charge. Mechanically admixed iron appearing in the foundry scrap or in floor sweepings can be removed by screening and forking, or by electromagnetic means if this is required.

Hard spots due to the brittle complex iron-aluminum alloy (iron-pot scale) which forms on the sides of iron pots may be largely prevented by thoroughly scraping the pots at frequent intervals and removing the accumulated scale. In the case of a single shift the pots should be scraped at least once a day, say at night, and probably better both at noon and night. If two shifts are employed, the pots should be scraped more frequently. All of the hard scale should be removed so that the pot is clean and, if necessary, the pot should be dumped. Also, during the time of melting, care should be taken that ladles or stirrers do not hit the sides of the pot; otherwise, some of the accumulated scale will be knocked off.

By careful attention to the foregoing items, the occurrence of hard spots in aluminum-alloy castings, which give rise to difficulty on machining and polishing, can be largely eliminated.

Castings Welded by Electric Arc Process

BY JOHN A. RANDOLPH

ELECTRIC welding is largely done by the arc method. Both direct and alternating current can be used for arc welding, but at the present stage of the art, direct current is the more generally employed. Alternating current, however, presents interesting possibilities which have not as yet been fully developed.

Either carbon, graphite, or metal electrodes can be employed. In the Bernardos process, which has been in use for more than 30 years, the filler metal is fed into the weld by hand from a metallic rod or bar. The movable electrode is made of a carbon pencil from 6 to 12 inches in length and from ¼ to 1½ inches in diameter, depending upon the character of the work. The metal to be welded is made the positive terminal of the electric circuit and the movable electrode the negative.

Table I

Relation of Plate Thickness, Current and Electrode

Plate thickness Inches	Current Amperes	Electrode diameter Inches
1/16	20 to 50	1/16
1/8	50 to 85	5/32
3/16	75 to 110	1/8
1/4	90 to 125	1/8
3/8	110 to 150	5/32
1/2	125 to 170	5/32
5/8	140 to 185	5/32
3/4	150 to 200	7/16
7/8	165 to 215	7/16
1	175 to 225	7/16

Two reasons account for this: first the heat developed at the positive terminal is generally 75 per cent hotter than that at the negative. Second, minute particles are thrown off from the positive terminal and carried to the negative. If the carbon were to be connected to the positive side, particles of carbon would be carried into the weld.

In the metal electrode process the work also is made the positive terminal. The movable metal electrode melts under the heat of the arc and serves as a filler. This is known as the Slavianoff process. The molten metal from the electrode is carried automatically, directly to the weld and the process is therefore particularly well adapted to vertical and overhead work.

The arc is formed by first touching the metallic electrode to the work and then withdrawing it. To secure the best results, it is necessary to manipulate the electrode until it is in the proper position. This position can be obtained by the maintenance of a short arc and an inclination of the electrode toward the work such as to offset the effect of draft currents.

The surfaces must be absolutely free from oxides and dirt, inasmuch as the presence of foreign matter will prove detrimental to the weld.

With the proper length of arc, the voltage across the arc will never greatly exceed 22 volts for bare electrodes and 35 volts for those of the coated type.

The coated electrode is made of metal but has a coating of some kind applied to its surface for the purpose of excluding, as far as possible, the atmosphere from the molten metal both while it is passing through the arc and after it has been deposited.

This method makes possible the use of electrodes of special alloy steel such as those varieties containing in combination respectively, manganese, carbon, nickel, vanadium and tungsten. Bronze and copper can also be used in welding through the medium of this type of electrode.

The size of electrode to be selected is dependent upon the type of joint to be made, the thickness and bulk of the work, and the current used. For instance, in the case of a lap joint, practically twice the amount of current is used and a larger electrode will be required than in the case of a butt weld. This is for the reason that the lap joint has a much greater capacity for heat storage and dissipation. In the case of two ½-inch plates welded in the lap fashion, the heat involved is practically equivalent to that of a butt

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Table II

Speeds of Cutting by Electric Arc

Thickness Inches	Current Amps.	Speed Minutes per ft.	Kw-Hrs. Per ft.
3/8	400	.50	.312
1/2	400	1.20	.75
5/8	400	2.14	1.34
3/4	400	3.00	1.88
1	600	3.75	3.50
1 3/4	600	4.32	4.10
2	600	6.75	6.30
4	600	16.90	15.50
6	800	29.00	36.20
8	800	40.50	50.00
10	800	59.00	74.00
12	800	65.00	82.00

The author, John A. Randolph, is associated with the Westinghouse Electric & Mfg. Co., Pittsburgh.

Discuss Problems of Electric Steel

Joint Meeting of Electrochemists and Electrical Engineers Considers Applications of the Electric Furnace for Making Steel and Ferroalloys—Operation of Two Furnaces in Parallel Is Proposed

THE future position of the electric furnace in the steel industry was discussed at a joint meeting of the American Electrochemical society and the American Institute of Electrical Engineers, held in Boston April 9 and 10. At the session held April 9 papers under the general heading "Electrically Produced Alloys" were presented. A plea for gathering and publishing existing data on standard alloys was made by H. E. Howe, vice chairman of the division of research extension of the National Research council.

A paper on recent developments in the ferroalloy industry, by Robert J. Anderson, United States bureau of mines, Pittsburgh, introduced an interesting discussion on the making of ferroalloys. C. B. Gibson of the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., presented a paper on the manufacture of ferroalloys in the electric furnace. The manufacture of high-speed steel in the electric furnace was the subject of a paper by Roy C. McKenna, president, Vanadium-Alloys Steel Co., Latrobe, Pa.

The joint technical session was continued during the evening of April 9 with a symposium on power for electrochemical purposes. H. L. Hess of the Hess Steel Corp., Baltimore, in a paper on the electric furnace and the central station, reviewed the difficulties commonly met with in connection with the great load fluctuations of earlier types of furnaces. The growing electric furnace industry is of such importance to the central station owner that he must make the problems of load fluctuation his problems and must work with the furnace manufacturer and the furnace operator toward the elimination of the objectionable features. To compete with others in his business the electric furnace owner must get his power at the lowest possible cost and to deliver power economically the central station man must have as nearly a uniform load as possible.

This same topic came up at the Saturday morning session and the question of using external reactances for correcting fluctuations was discussed at some length. Mr. Hess devoted much attention to the operation of the electric furnace seen from the metallurgist's point of view. Correctly operated, the electric furnace is a large crucible, heated by pure heat from within, rather than a contaminated heat from without, with all the added advantages of positive heat control and to a large extent, atmospheric control as well. Open-hearth electric steel, which consists of metal taken from the open-hearth furnace and charged hot into an electric furnace for further refining fills the want for high quality steel at a price consistent with competitive requirements. Such steel does not, however, compare with the higher grades of cold melt electric steel. The discussion of Mr. Hess's paper centered about the future use of the electric furnace in conjunction with the converter and open hearth. The statement was made that eventually all steel will be put in electric furnaces for a last refinement.

Operating Furnaces in Parallel

In a paper on power problems from the standpoint of the furnace operator, Wallace G. Berlin described the use of two furnaces in parallel so as to reduce the "demand" power and to enable the use of off-peak power. Incidental to the general discussion of this paper a concise and comprehensive description of the usual practice in making steel in the arc type of furnace was given. As soon as a heat is poured out of the furnace the banks are patched with dolomite and the next charge, consisting of heavy melting scrap, is introduced. The electrodes are then lowered and the current turned on at full capacity of the transformers. In about 30 minutes a pool of molten metal is formed under each electrode. During this period the power fluctuates heavily. Lime is then added and the power input settles down to a steady value. In about 1 hour and 45 minutes the charge is melted and carbon determined. The bath is then *ored down* or *pigged up* until the proper combustion is reached. The slag is then drawn off and a new slag made, of lime and fluorspar. After coking over with ground coke, the desulphurizing and deoxidizing start and in 20 minutes a white slag is formed which completely deoxidizes the steel in about 30 minutes. Alloy additions are then made and the heat brought up to a pouring temperature. From this it may be seen that by operating two or more furnaces in parallel with about an hour's difference between one and the next, the current fluctuations in one furnace will occur at the time of steady load of another and so the per cent of fluctuation of the total load will be greatly reduced.

The Saturday morning session was devoted almost exclusively to a symposium on electric furnaces. Joseph W. Richards presented an interesting paper on the Soderberg self-baking continuous electrode. This electrode embodies the idea of feeding continuously unbaked electrode mixture to the furnace, the mass being baked by the heat of the furnace in which it is being used, and the apparatus being so arranged that the operation is practically continuous throughout the life of the furnace.

The manufacture of pig iron in the electric furnace by the recarburizing fusion of steel scrap was the subject of a paper by C. A. Keller.

A description of the various types of brass furnaces and the evolution of these down to the present day practice was given by H. M. St. John of the Detroit Electric Furnace Co. Other papers and general discussion of this session predicted the future importance of the electric furnace in iron and steel metallurgy.

On Friday afternoon nearly all those attending the conventions went in a body to visit the Lynn plant of the General Electric Co. The Saturday session was followed by an inspection of the Harvard university chemical research laboratories and then a lunch at the Harvard Union. In the afternoon many of the visitors took advantage of the invitation of the Huff Electrostatic Separator Co., Arlington, to inspect the company's plant.

Other features of entertainment during the conventions included a smoker at the Arthur D. Little, Inc., laboratories in Cambridge and an informal subscription dinner at the Copley Plaza hotel held by the American Institute of Electrical Engineers, but open to the members of other societies.

During the convention, the American Electrochemical society elected the following officers for the current year:

President, Walter S. Landis, chief technologist, the American Cyanamid Co., New York; vice presidents, John A. Mathews, vice president, the Crucible Steel Co. of America, Pittsburgh, L. E. Saunders, vice president, the Norton Co., Worcester, Mass., A. T. Hinckley, chemist, the National Carbon Co., Niagara Falls, N. Y.

Would Train Electric Furnace Operators

BY ACHESON SMITH

DURING the war it was difficult, and at times practically impossible to find men to operate electric furnaces, as the furnaces were being installed more rapidly than men were being trained. After the signing of the armistice the demand for furnace operators was less acute. It was then found that while the supply seemed to be adequate, there still was a marked scarcity of desirable men. The trouble seems to have been that many men were drawn into this work who were not naturally fitted for it or not suitably trained, with the result that they either dropped out and took up other work, or were set aside for better talent as soon as the higher grade men could be procured. The result of this condition is that there still is a real need for competent men in practically all lines of electric furnace work.

The term *melter* designates the man in immediate charge of a furnace. By *metal superintendent* is meant the man to whom the melter is responsible. He may have any title in the foundry or steel works, but his duties are primarily to successfully operate one or more electric furnaces. Such a man should have a thorough knowledge of the metallurgy involved; a complete understanding of the design of the furnace; an adequate knowledge of the electrical problems met both by the designer of the furnace and supplier of power; a practical understanding of the power service situation; and how the operation of the furnace affects the power company. If the man has such comprehensive technical and practical knowledge of the various ramifications of electric furnace work, he will so operate the furnace that he will not only get highly satisfactory results as to the quantity and quality of his output, but will avoid mechanical and electrical disturbances which would injure the operation of the furnace and disturb the power service.

In the automotive industry, which is said to be planning to manufacture 3,000,000 cars in 1920, the demand for automobiles is at present in excess of the supply. Those in charge of production are fully alive to the desirability of producing a car that will be, if possible, more reliable than they have been heretofore, and their constant aim and endeavor is to use more dependable materials in the manufacture of their cars. This is now creating and will undoubtedly permanently establish a large demand for higher grade steel and brass, as well as other metal. There also are many other industries into which the high grade steels, which are made in the electric furnace, will enter. Therefore, it is probable that a continuous increase in electrically produced steels and alloys will take place, which of course means that suitably trained men must be found to operate the furnaces if they are to be run successfully.

Need for Melters Grows

While the work of a melter is rough and at times very arduous, it probably offers one of the best opportunities now open to young men who are not afraid of hard work. In addition to being highly remunerative, it is likely to lead to a position of greater responsibility. Making steel and other products in the electric furnace is in its infancy and will grow to great proportions as the years go by. There also probably is no quicker way for a man to establish a reputation as a metallurgist than to engage in the production of metals in the electric furnace.

The universities are providing technical courses to fit their graduates for electrical engineering and metallurgical work and undoubtedly some of them are teaching the principles involved in the use of the electric furnace, but there seems to be a serious lack of practical training for men to fit them to properly hold positions with companies operating such furnaces.

To give students a thorough working knowledge of the design and operating of electric furnaces, different faculties will undoubtedly adopt different methods. It might be done by operating small furnaces in the university laboratories and thus giving the students some practical training. It might be accomplished by adding to their theoretical studies, visits to plants operating different types of electric furnaces. Perhaps extension work could be arranged whereby the student could work for several months in plants operating electric furnaces and be given credit in the university for such work. It is possible that practical training could be given as graduate work for a higher degree, which, of course, would have some advantages. It is possible that some institutions of learning will be able to install furnaces of each distinct type for producing steel and brass and for heat treating, and thus be able to give their students a thorough practical training in the operation of each type of electric furnace. Undoubtedly some or all of these methods will be used to fit men for this very important work.

From a paper presented at the meeting of the Electric Furnace association at Boston, April 8, 1920. The author, Acheson Smith, is president, Acheson Graphite Co., Niagara Falls, N. Y.

Castings Welded by Electric-arc Process

(*Concluded from page* 342)

weld of two 1-inch plates. Table I shows the approximate values of current and electrode diameters for welds using plates of varying thicknesses.

Another use for which the electric arc is employed is cutting. For this purpose, the carbon electrode process is employed. The amount of current required depends upon the thickness of metal and the speed desired. It usually varies between 350 and 800 amperes. Table II shows the value of current, and speed and kilowatt hours per foot for cutting steel plate by this method.

The standard voltages on circuits used for light and power are generally 110 or 220 volts, a value much higher than that required for welding which is usually not over 50 volts. If the welding circuit is connected directly to a power supply of standard voltage it is necessary to reduce the pressure by means of a resistance placed in series with the welding circuit. This causes a considerable loss of power through heating, in the resistance. To obviate this difficulty, an indirect method employing a motor generator set is used, the motor being connected to the supply circuit and the generator to the weld. The generator is designed to furnish directly the range of voltages required by the arc, the pressure being varied by regulating the field excitation of the generator. There is thus no material loss of power between the supply source and the weld.

New Foundry Is Model of Efficiency

Maximum Production With Unskilled Labor, and a Smoothly Running Organization Are Outstanding Features of a Foundry Which Was Planned To Secure Efficiency

FOUNDRIES have been perhaps the slowest of the allied iron and steel producing class to respond to the trend of modern industrial methods of production. There are many reasons for this apparent indifference on the part of the men engaged in the business for not availing themselves of modern ideas or from putting them into practice. One reason, of course, is the conservatism which obtains among foundrymen to a great extent; another is that it has been possible to operate at a profit for a number of years under existing conditions largely owing to the fact that the other fellow was in the same boat. However, the principal reason perhaps lay in the fact that to adopt new methods meant scrapping much existing equipment, erecting new buildings, and developing an entirely new organization.

The tremendous volume of business created during recent years together with a corresponding decrease in the number of men qualified to work in foundries according to the old accepted standards has turned the minds of many executives to ways and means by which to manufacture their products differently. The advent of the molding machine and other labor saving equipment have had a tremendous influence in expediting the movement. Labor saving is not exactly the term to apply to these innovations of recent years; rather they should be termed labor expanders. The man using a molding machine, for instance, works just as hard, and for the same number of hours as formerly, but his output of molds is increased to a remarkable degree.

A feature of the industrial situation which has been apparent to many executives for years and which is becoming more apparent every year is that there are many factors besides compensation entering into the problem of building up and holding an organization together. Adequate compensation, of course, always will be the dominating factor in the majority of cases; but running a close second, and sometimes even nosing ahead, must be reckoned the influence of congenial surroundings and working conditions. The average man prefers to move in a rut, he likes it. There is a universally, if sometimes unspoken desire, on every one's part to "Let George do it." It is many centuries since men ceased to worry about what they should eat, or what they should drink or wherewith they should be clothed. A few individuals figure all these things out and men calmly accept their dictum and govern themselves accordingly. The phenomenal efficiency and success of some nationally famous industrial establishments is based on the fundamental truth that while nearly every man is at least willing to try to play a solo, few are either willing or competent to play every instrument in the band. A smooth running organization is one in which the executive head has divided the work into all the necessary component parts and then assigned the parts definitely among the workmen.

Among the establishments notably successful along these lines is the Peerless Foundry Co., Cincinnati. The business first was located in Hamilton, O., and while it is possible that the company eventually would have arrived at its present stage, that event was hurried or rather forced upon it by a fire which burned the Hamilton plant completely to the ground over a year ago. The volume of business on hand together with that in prospect influenced the company under the direction of the president George F. Dana to rebuild immediately. A favorable site was secured in Elmwood, a suburb of Cincinnati, which has proved eminently satisfactory, situated at a desirable shipping point and with a good labor market.

The general layout of the plant, which was designed by Frank D. Chase, Inc., industrial engineer, Chicago, is shown in Fig. 7. The dotted lines to the right indicate the proposed extension now under consideration which will be utilized as a molding floor and will increase the capacity of the plant by 50 per cent. The location of the different molding units is indicated on the plan. As will be noted the foundry building proper is 121 x 200 feet, and presents an un-

FIG. 1—THE FURNACE IS ALLOWED TO FILL UP, THEN THE SLAG IS COLLECTED IN A WHEELED LADLE AND CARRIED OUT TO THE DUMP

broken molding floor excepting for the space the cupolas occupy in one corner.

The roof is supported by the walls and by two rows of steel columns. It is a modified Pond-truss type and in common with the side walls is composed largely of glass. One row of windows in both walls and roof is hung on pivots and furnishes ample ventilation. The building is heated, when necessary, by a hot air system installed by the Robert Gordon Co., Inc., Chicago. The heated air is taken away from the furnace by a fan, and discharged out of the top of the heater in such a way that the hot air is blown into the further corners of the room, which gives a uniform temperature throughout. In addition to heating the shop this system prevents, to a great extent, the generation of steam while the molds are being poured. Since the air is warm the steam generated does not condense and this makes for much pleasanter working conditions than usually is the case. This feature will be better appreciated when it is understood that pouring goes on continuously all day, commencing about 9:30 a. m. and finishing about 4 p. m.

The company specializes in light castings which to a great extent are assembled with little or no machining and therefore must possess a high finish and be accurate to within narrow limits. A grade of Newport, Kentucky sand is used exclusively. The banks are not far from Cincinnati and the sand seems to possess all the necessary qualifications for imparting a smooth skin to the castings. The patterns for all the work are mounted on pattern plates and follow boards and the molds are rammed on a battery of 76 power squeezer machines manufactured by the Osborn Mfg. Co., Cleveland. Three highly skilled men are employed as instructors. These design and layout the work and keep the equipment in good running order. The machine operators have been recruited from the ranks of unskilled labor and although the shop has been running less than a year some of these men, have for some time, been making $10 a day.

A combination pattern and stripping plate which has been found to give excellent results on the class of work handled in this shop is shown in Fig. 3. It consists of a light but rigid white metal frame the same size and shape as the frame of the snap flask on which it is destined to be used. A rod extends through each end terminating in a pair of rollers. Through a suitable cam arrangement, these rollers are actuated by the toggle jointed lever thus raising the frame and patterns a sufficient height to clear the mold. It was intended primarily to throw the lever and raise pattern and cope together, but it has been found in practice that better results are secured by lifting the cope off first then, when the lever is used to draw the patterns they can be watched and if necessary rapped or otherwise manipulated to secure a perfect draw.

Almost all of the patterns are mounted on follow boards made of rattler dust, linseed oil and litharge. Enough linseed oil is added to the sand to make it a little damper than ordinary molding sand and about a handful of litharge added to a quantity of sand sufficient to make one follow board. After the follow board has been made it is set aside for a day or two to harden and then is given a coat of black shellac, after which it is ready for use. One man is kept constantly employed in making follow boards and work connected with their upkeep. Usually the company's customers furnish their own patterns but there is a completely equipped pattern shop on the premises in which metal patterns are made and repaired. In this shop patterns like those shown in Fig. 3 are attached to the frames by soldering or brazing. Some of the racks in the pattern storage room are shown in Fig. 4. The fragile nature of some of the work also will be noted. The resistance grids shown near the center of the illustration are so light and limber that they can be folded double without breaking.

When the new shop first was placed in operation, 45 pneumatic squeezers made by the Osborn Mfg. Co., Cleveland, were installed; but this number was soon found to be totally inadequate to keep up with the volume of orders. Therefore, an additional 31 similar machines were ordered and upon their arrival it became necessary to plan an entire re-arrangement of the molding floors and other details so

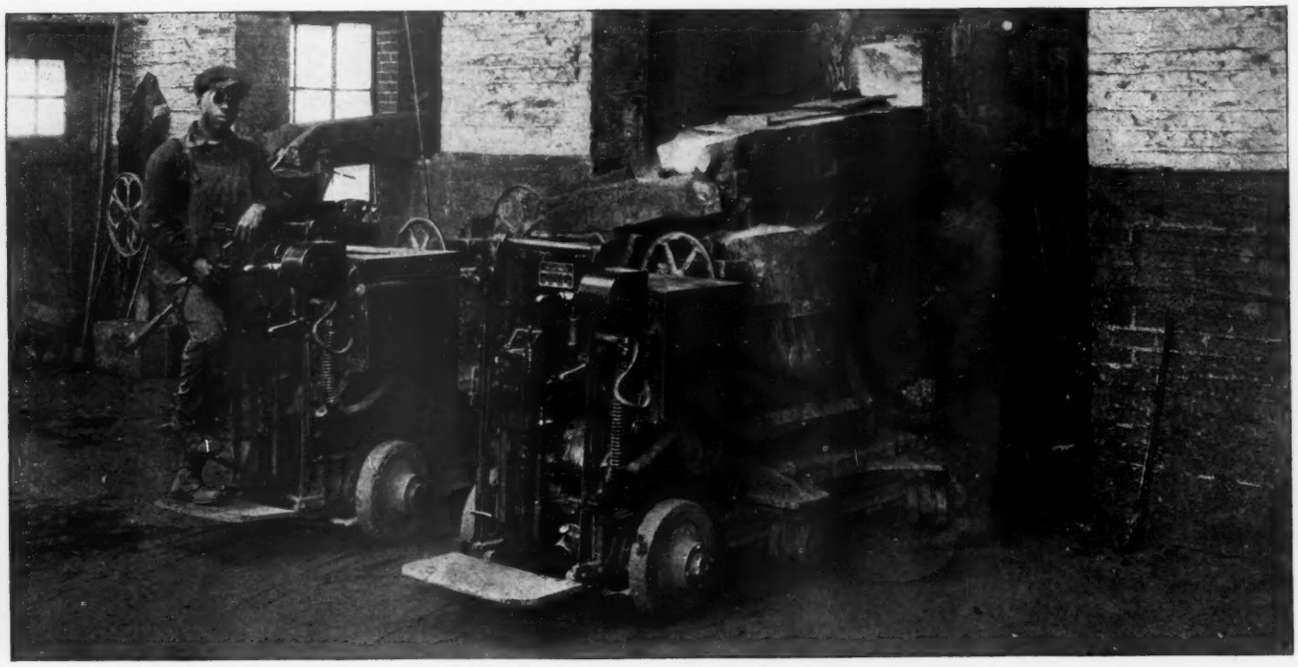


FIG. 2—TWO AUTOMATIC LIFT TRUCKS ARE EMPLOYED TO DISTRIBUTE THE IRON TO THE DIFFERENT FLOORS DURING THE DAY—THE SHORT SPOUT CAN BE ADJUSTED TO FILL EITHER LADLE

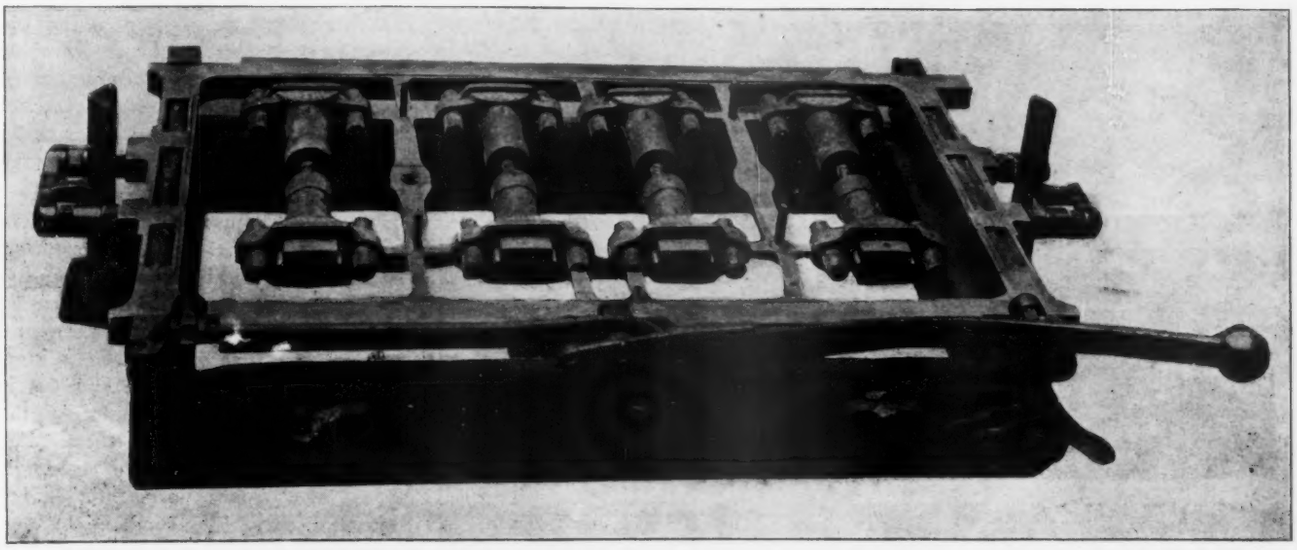


FIG. 3—A PATTERN PLATE WHICH ALSO ACTS AS A DRAWING DEVICE—THE LEVER ON ONE SIDE OPERATES THROUGH A TOGGLE JOINT AT THE CENTER AND RAISES OR LOWERS THE PLATE

as to work the equipment to the best advantage. Up to that time the days heat was poured off in the usual way in a couple of hours in the afternoon. This meant that each machine operator needed a large space on which to put up an entire day's work. To eliminate this objectionable feature and to provide room for two men where one man worked before, the present plan of pouring continuously was placed in effect some time ago. This has resulted in increasing the output practically 100 per cent from the same floor space. The relative location of the molding units is shown in Fig. 7. The most intensely productive space is that in the center where the floors are found to be just the ideal length for capacity production. The floors at the side are too long for single floors and not quite long enough to permit of a gangway at the back. If it were possible to run a gangway so that the floors could be arranged like those in the center bay the output would be increased considerably.

The entire floor of the shop is surfaced smoothly with cement which makes for efficiency in various ways. This facilitates the use of a machine supplied by the American Foundry Equipment Co., New York, for cutting over the sand by night. A wide gangway extends across each end down both sides between the center and side bays.

Two lift trucks made by the Automatic Transportation Co., Buffalo, are kept busy all day distributing the molten iron into hand ladles on these gangways. The spout of the furnace discharges into a short transverse spout mounted on a pivot which allows it to discharge metal into two ladles alternately. The ladles are carried on small iron trucks running on casters so that they can be pushed around by hand if necessary. This method of handling the iron would be rapid enough if the quantity was small or if the furnace melted slowly; but in the shop under discussion a much faster distribution is necessary. The automatic lift trucks have solved that problem. They are driven at an apparently reckless speed but with a skill that would excite the envy of Ben Hur. The way they can swing up the gangway, make the turn, back up and roll into position under the spout is a poem in motion. When not engaged in distributing the iron these trucks with two others are used for a variety of purposes. They are employed in the yard for hauling charges to the cupola elevator; in the foundry for carrying castings to the cleaning room, cores from the core racks to the molding floors; for hauling castings from one department of the cleaning room to another and finally for loading the castings on the cars for shipment.

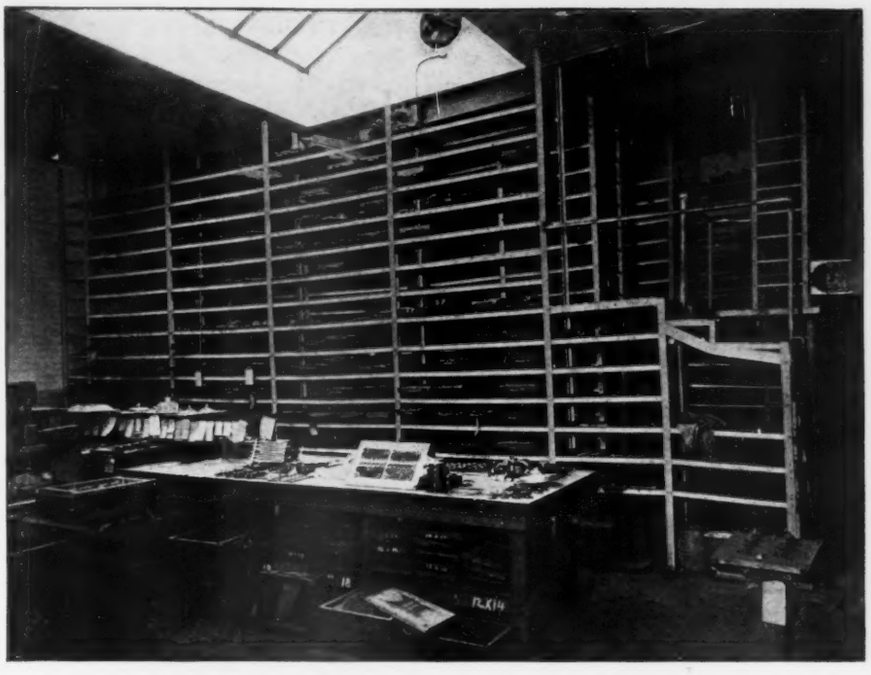


FIG. 4—ONE OF THE RACKS IN THE PATTERN STORAGE BUILDING

Two Whiting cupolas, each lined to 52 inches are used on alternate days for melting the iron which is charged in 3000-pound lots separated by 500 pound layers of coke. The charge consists of approximately 50-50 pig iron and scrap. A portion of three and sometimes four varieties of pig iron is constantly used for each

FIG. 5—THE TUMBLING BARRELS ARE DRIVEN FROM ONE CENTRAL SHAFT AND ALL ARE PROVIDED WITH DUST ARRESTING CONNECTIONS—NOTE THE WIRE GUARD AT THE END AND THE GEAR COVERS OVER ALL THE DRIVING MECHANISM

charge, but the only scrap used is that produced within the shop. On account of the particularly light and fragile nature of most of the work, the amount of iron in the gates and runners nearly equals the amount in the castings. The company figures that if it secures 55 per cent by weight of good castings in proportion to the weight of iron charged it is as much as reasonably could be expected. The blowers for the cupolas and compressor for supplying air to the molding machines are situated in a room immediately below the charging floor. Twin blowers supplied by the Connersville Blower Co., Connersville, Ind., are mounted in line with each other. Only one is used at a time the other being held as a spare with the driving pulley removed. The blower is capable of delivering 17 cubic feet of air each revolution. It is belted to a 30-horsepower motor made by the Allis-Chalmers Co., Milwaukee, operated at 860 revolutions a minute. The driving pulley on the motor and the driven pulley on the blower are in the proportion of 1 to 3, which results in a delivery of about 5000 cubic feet of air a minute or 300,000 cubic feet an hour which is sufficient to melt 10 tons of iron.

The iron charges are made up in the yard on small wooden platforms, mounted on skids which are high enough for one of the lift trucks to slip in under and pick it up. The truck and load are taken on an elevator to the charging platform where the load is deposited in a convenient place for charging. Instead of allowing the slag to accumulate at the back of the furnace while the heat is running, it is taken away at regular intervals in the small slag ladle shown in Fig. 1. This is one of the details which serves to keep the shop always in a neat and orderly condition. Another is the system of supplying a cast-iron pig mold at the base of every column in which the men dump whatever iron is left in the ladles. A number of these molds also are provided near the furnace in which to spill any excess metal. A wet mill is set up back of the cupolas and all of the cupola drop is passed through it.

The core room is situated adjacent to the end of the foundry, but is separated from it by a brick wall and passage. It is provided with the usual benches, sand mixing machinery and core ovens. The large oven is provided with a door at each end. It is fired by gas, the heat entering the oven through a row of rectangular ports in the center of the floor. A large open funnel suspended over each end serves to remove the gas and smoke from the oven when it is first opened. The cores are turned out on plates which are loaded on racks of the type familiar in all light work shops. When the racks are filled one of the lift trucks is employed to transport it to the oven. Female labor is used exclusively in the core room. Working on a piece work basis some of the girls earn from $35 to $40 a week. The work is light and clean and they seem to be well contented.

The casting cleaning department is divided into two sections. One contains the tumbling barrels and sand blasting machinery and the other the grinding wheels. As will be noted in Fig. 5, the eight tumbling barrels are mounted in pairs. A 7½-horsepower Allis-Chalmers motor furnishes

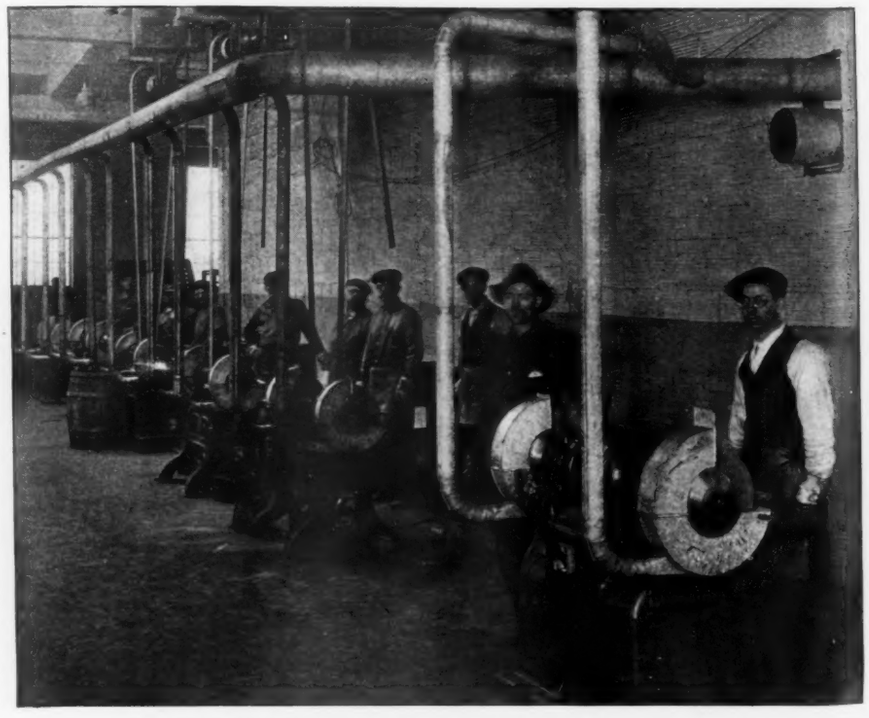


FIG. 6—THE GRINDING WHEELS ARE PROVIDED WITH DUST COLLECTORS

the energy for driving the battery. They all are driven from a common center shaft and since each is equipped with a clutch connection, any one may be started or stopped individually. A chain block suspended over each barrel is used for lifting and holding the door while the barrel is loaded and emptied. The system of dust arresting also is shown in the same illustration. The suction fan is driven by a 15-horsepower Allis-Chalmers motor. Two sand-blast tumbling barrels supplied by the New Haven Sand Blast Co., New Haven, Conn., are shown in the background. Each of these is driven by its own individual motor.

A battery of grinding wheels in the second division of the cleaning room is shown in Fig. 6. Three of these units are belt driven from a countershaft which in turn is actuated by a 10-horsepower Allis-Chalmers motor and the other three are direct driven from individual motors.

The castings are taken from one room to the other in square wooden boxes mounted on four legs terminating in casters. These trucks may be pushed around by hand, or, when necessary, one of the lift trucks can be employed to carry them from place to place. This room also is provided with tanks and an oven for applying a coat of lacquer to castings which require such treatment. The castings are strung on rods and dipped into the tank, after which they are left to drain. They then are placed in racks similar to those on which the cores are dried. When the racks are filled, they are conveyed to the oven, which is fired with gas like an ordinary core oven. Here they are left until the temperature has reached 350 degrees Fahr. The heat then is shut off and the articles are left in the oven until it cools.

The shipping room is adjacent to the cleaning room. Here the castings after having been weighed and inspected are packed into barrels and shipped by rail or truck to their destination. The predominating note struck in this plant is system, order and neatness.

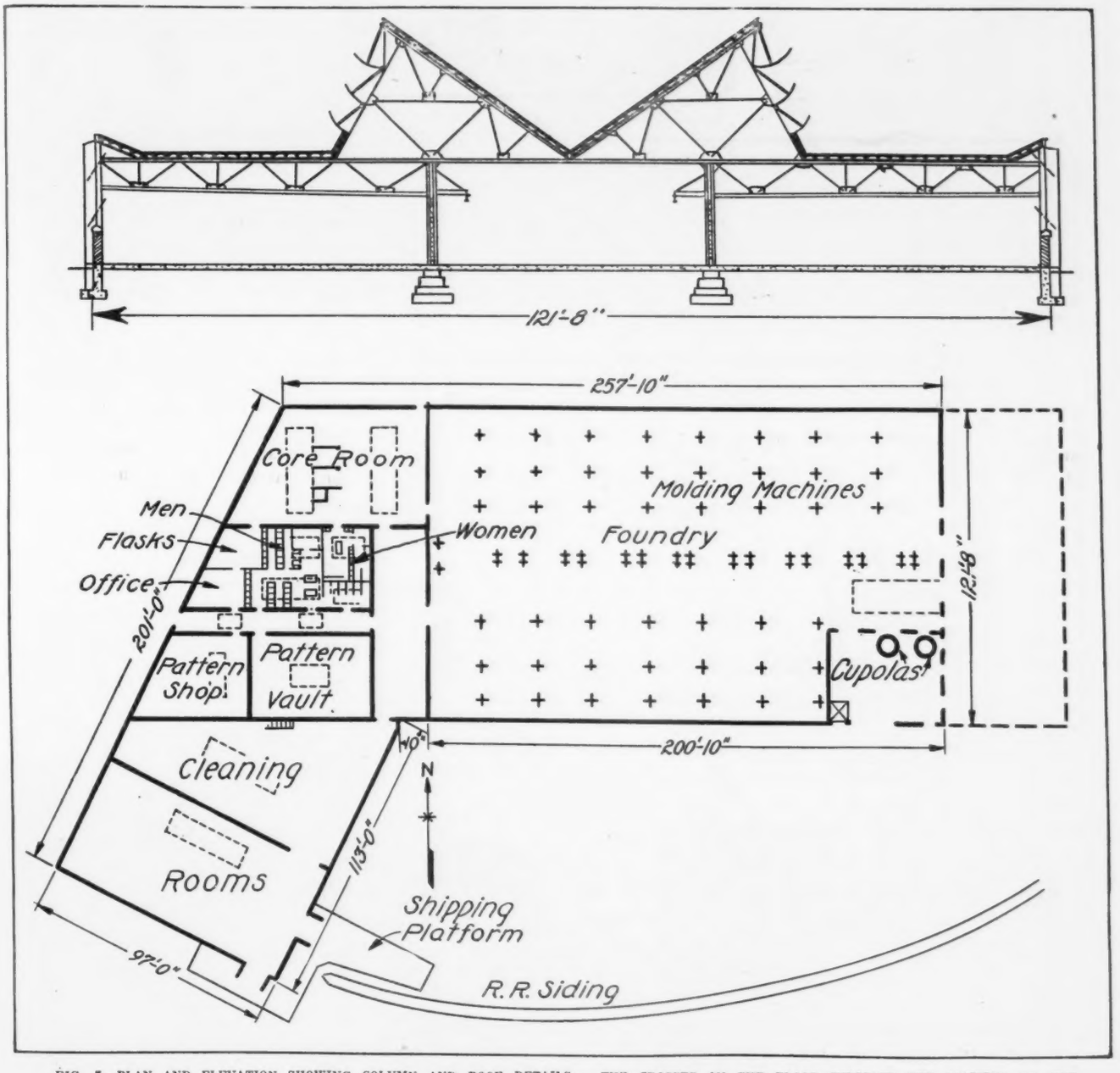


FIG. 7—PLAN AND ELEVATION SHOWING COLUMN AND ROOF DETAILS— THE CROSSES ON THE FLOOR INDICATE THE POSITION OF THE MOLDING MACHINES

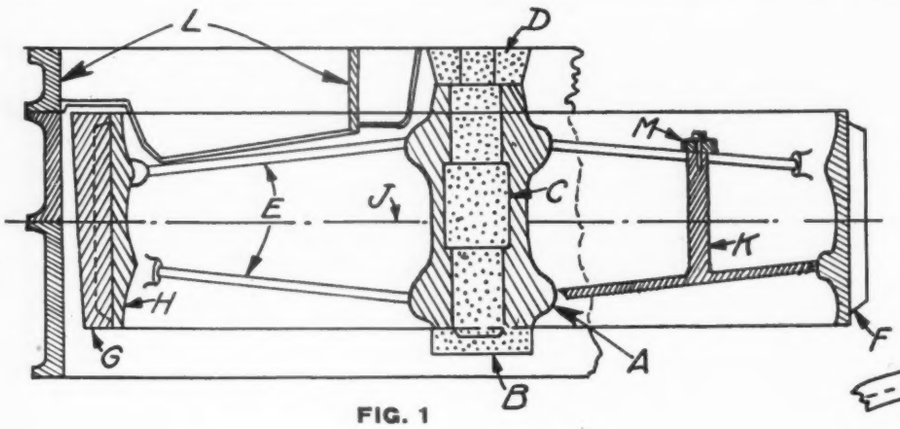


FIG. 1

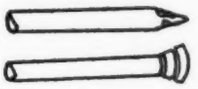


FIG. 2

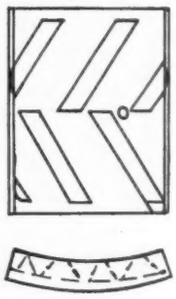


FIG. 3

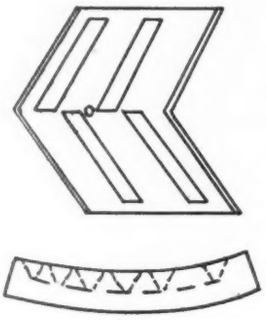


FIG. 4

FIG. 6

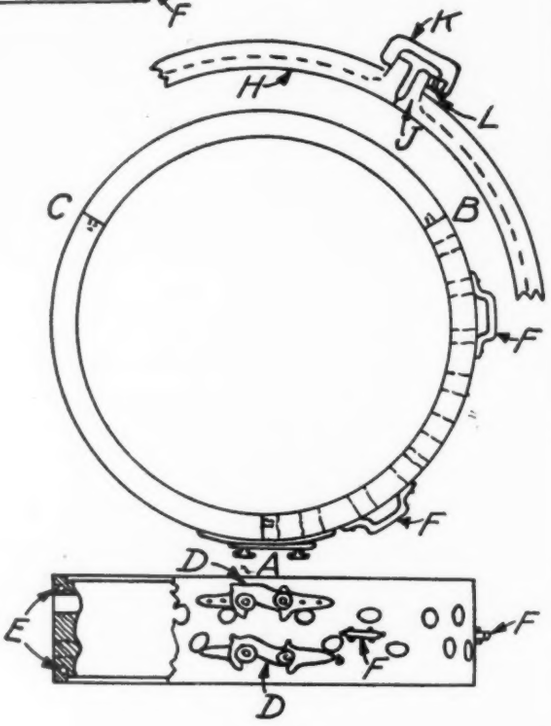


FIG. 5

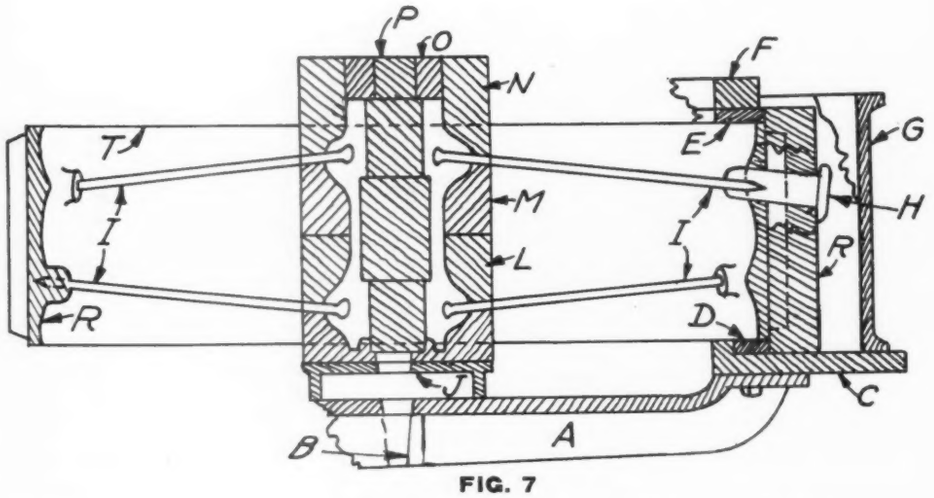


FIG. 7

FIG. 8

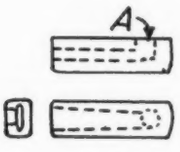


FIG. 9

FIG. 1—CROSS SECTION OF ASSEMBLED MOLD AND CASTING FOR TRACTOR WHEEL AS IT IS USUALLY MADE FIG. 2—THE ENDS OF THE STEEL SPOKES ARE FLATTENED AND GROOVED ON THE ENDS FIGS. 3 AND 4—DETAILS OF CHILLS FOR FORMING CLEATS ON THE RIM FIG. 5—THE PATTERN IS A PLAIN RING SPLIT VERTICALLY AT THREE EQUIDISTANT POINTS—ABOVE, THE FLASK IS SPLIT TO ALLOW FOR EXPANSION FIG. 6—ANCHOR PLATES USED IN OLD METHOD FIG. 7—CROSS SECTION OF ASSEMBLED MOLD MADE BY THE NEW METHOD FIG. 8—DETAIL OF BOSS SHOWN AT *H*, FIG. 7 FIG. 9—GATE CORE

Tractor Wheel Molding Simplified

The Pattern Is Split Vertically into Three Sections to Obviate the Necessity for Making Two Partings and Lifting the Green Sand Core When Molding These Wheels

BY H. N. TUTTLE

CAST iron agricultural tractor wheels have their hubs and rims made of cast iron and their spokes of steel. The spokes are set in the mold and the iron cast around the ends of them as shown in the accompanying illustrations. The outside face of the mold is made with chills to harden the grousers or cleats. The former and usual method for molding these wheels is shown in Fig. 1, which represents a cross section of the wheel and mold. The hub is shown at *A*, with the dry sand cores in place. The seat core, *B*, is rammed in place, to support the center core *C*. A ring core, *D*, slips over the top tenon end of the center core, thereby cutting off the hub to the required length. It has been found that this gives a more accurate hub length than the standard type of cope core print, for any lifting or straining of the cope does not lengthen the hub.

The steel spokes *E*, which range in size from ⅝ to 1 inch, according to the size of the wheel, are cast in place. The ends of the spokes are flattened and grooved, as shown in Fig. 2, to allow the iron to get a better grip by welding and shrinking around them. A cross-section of the rim is shown at *F* and *H*, Fig. 2 *G* is a section of the chill. The pattern itself is made of segments well spiked and glued, and of the shape of *H* and *G* together. Fig. 3 shows one of the chills, the whole mold requiring from 12 to 18 chills, according to the size of the wheel. The pattern is split on the line *J*, and the spokes *E* in the pattern are made of wood.

In making the mold, a set of anchor plates *K*, Fig. 2 (also shown in detail in Fig. 6) are placed on the followboard, one between each pair of spokes, the stud at *K* being dropped through a hole in the followboard. After the drag is rammed and rolled, the space between the spokes is rammed. A second parting is made by hand along the line of the top row of spokes. Pieces of paper or waste are used to keep the sand out of the tapped holes in the top of the studs, *K*. It will be noted that this stud, *K*, is located at one side of the center of the anchor plate. This is so that it will not interfere with the top spoke. The cope *L* is then rammed, the print for the core *D* being loose and tapered is drawn from the top of mold.

After the cope has been lifted off, and the top half of the pattern drawn, the ring *M* is placed in position on top of the studs *K* and fastened to them by cap screws. The green-sand core between the spokes then may be lifted by this ring, after which the lower half of the pattern may be drawn. The lower row of steel spokes then is set and the sand between the spokes returned, after which the upper row of spokes are set. The chills are then assembled in the mold, being let down by means of two lifting hooks provided in the top of each for that purpose. The cope is returned, the gates and runner boxes prepared and the mold is ready to pour.

If the mold is gated at a point above *H*, with four gates and poured with two bull ladles for the rim, and poured through the center core with four gates, two near the bottom and two about half way up, satisfactory results generally will be obtained. The rim and hub cannot be poured on the same day, as the shrinkage of the rim will bend the spokes out of shape. The hub is poured on the following day. The shrinkage of the hub will put tension on the spokes.

Improved Method Outlined

The new method of molding this style of wheel shown in Fig. 7 has reduced the molding time about 50 per cent. The plan of the pattern is shown in Fig. 5. It is a plain ring about four inches thick, well nailed and glued for strength, and of the same shape as the inside of the required casting. It is sawed into three segments, on lines *A*, *B*, and *C*, and held together by heavy malleable iron hooks, *D-D*. Two large dowell pins *E-E*, are placed in each joint. The pattern is drawn away from the mold in a radial line, by the handles *F F* two of which are attached to each section.

Referring to Fig. 7, which shows the rigging for this method of molding, *A* represents a four armed spider, which is bolted rigidly to the large ring plate *C*. The taper spindle hole is shown at *B*, the spindle not being illustrated. The spider and bed plate *A* and *C* are let into the foundry floor, being properly underlaid with a coke bed for drawing gases from the bottom of the mold. The pattern is hooked securely together and placed on the ring plate *C*, being centered on the plate by a circle of slab segment cores *D*, which back up against the rib shown as part of floor plate *C*. By changing the width of this core, different sized wheels may be cast on the same floor plate.

The mold procedure is simple. A spindle is placed in the spindle hole *B*, and if the hub of the pattern is so high as to make it worth while, as in the case shown in the illustration, a cast iron stool or table *J* is placed over the spindle on the floor plate. The bottom core is placed over the spindle, resting on table *J* and centered by the hole through the center which fits the spindle. After ramming nearly to the top of this core, the steel spokes are set in notches in the core on the hub end, while the rim end is set in the spoke bosses. One of these bosses is shown in Fig. 8, and has a slotted hole in the end, to let in the swaged end of the spoke. These spoke bosses extend through the pattern rim as shown and are locked in position by a simple stop which is not shown. Core *L* is now set, the mold rammed up a single course, and core *M* is set. Cores *L* and *M* are centered by a wood collar set over the spindle.

When the ramming has almost reached the second row of spokes, these are inserted in place, and the ramming proceeds, the top core, *N*, being set last. A wood cover is dropped over the spindle while ramming the mold to keep the sand out of the center cores. Proper markers are made on the hub cores, so that they will be piled up with the correct location of spokes and other lugs and bosses which probably will be required on the casting. After the spindle has been withdrawn, a piece of waste, covered with a little sand, is placed in the hole *B* before placing the center core. When the ramming has reached *T*, or the top of the rim, a bed is struck from the shoulder on the pattern and a row of slab segment cores, *E*, placed against the pattern. Then a heavy weight ring, *F*, is set on each of these cores.

It now is time to draw the pattern, but on account of the spokes extending into the spoke bosses in radial lines, it is necessary to remove these before the pattern may be drawn. This is easily done by drawing each boss separately through the pattern rim. Now each

one-third section of the pattern may be pulled back by the handles, *F-F*, Fig. 5.

After the mold is finished, which is done easily on account of accessability, the chills are set. As the chills do not have to be let down from the top, they are made in the shape shown in Fig. 4 which makes a better looking casting than the chill in Fig. 3. When the chills are set, and the cracks between them daubed with fireclay, the flasks or *jumper, G*, Fig. 7, or *H*, Fig. 5, is set over the mold, and the space between the chills and flask rammed with dry sand. Iron wedges are dropped back of the chills to resist the pouring strain. The chills are made with from ⅛ to 3/16-inch clearance space between. They increase in size slightly, as they grow old.

It will be noted that the flask is made with an open joint, *J*, Fig. 5. The parts are held together by the steel clamp *K* and steel wedge *L*. After the casting is poured and slightly set, the flask is released by knocking out the wedge; otherwise the expansion of the chills will break the flask. This is explained by the fact that the iron runs in between the chills and sets, thus virtually making a solid iron ring, and as the casting heats the chills, this ring will increase in size possibly ⅛-inch or more in diameter. Fig. 9 shows the gate core, which is set at point *R*, the gate stick being set in the hole *A*. It will be noted that the gate widens where it joins the casting. This reduces the force of the flow of metal against the chills. In these drawings the braces or lugs by which the master gear is fastened, as well as various other lugs and bosses, are omitted for the sake of clearness.

Permanent Iron Molds Are Not Perfected

By H. E. Diller

Question—I am aware that considerable development has occurred in connection with the use of permanent molds for the production of gray-iron castings. Will you please let me know the present state of the permanent mold, giving the composition of the metal used and other facts which would help me in the use of such molds. I may add that my inquiry is concerned with the question of developing the foundry industry in Australia.

Answer—As far as we know, there are no foundries using permanent molds to any great extent for making gray-iron castings which require machining. One foundry which makes cast-iron water pipe uses the permanent mold. It has been operating on this basis for about two years. Of course these pipe do not have to be machined and so any small chilled areas are not detrimental to the product. One foundry producing the general run of iron castings made a serious attempt to operate entirely with permanent molds but had to change back to sand molds. The trouble was that no matter what iron was used, there would be chilled spots on some of the castings at the corners and at the thinner sections. These chilled areas would dull cutting tools unless the castings were first annealed. In order to soften the castings sufficiently, the anneal would have to be conducted at such a high temperature that the castings were deteriorated. The cost of annealing the castings also would act to offset any expense which might be saved in using permanent molds.

However permanent molds are used to a slight extent in many foundries for special purposes and ultimately will be used to a greater degree. One foundry uses permanent molds to cast elbow pipe for high pressure steam lines. The advantage here is not primarily one of cost but to secure a denser metal. In the Nov. 15 issue of THE FOUNDRY an account of a patented process for making radiator sections in permanent molds was published, however, this process has not yet been put on a commercial basis. An account of how permanent molds were tried for casting piston rings and abandoned is noted in the first article in THE FOUNDRY of Feb. 15.

Permanent molds are made of a gray iron having a high percentage of combined carbon. This is obtained by keeping the silicon content low, the amount being regulated by the size and thickness of the mold. Between 1.25 and 1.75 per cent silicon is the usual amount desirable. Sulphur may be comparatively high and sometimes amounts to 0.20 per cent.

The mold should be thick enough to absorb the heat from the molten iron without becoming red hot and still not be too heavy for handling. A section 1½ to 2 inches thick usually is found to answer the requirements. Before pouring the first casting each day the mold should be heated slightly to dry the graphite wash which should be applied to it after each day's run. At first the graphite wash is applied more frequently, until the mold becomes seasoned. Care should be taken to see that the mold does not become red hot. This can be avoided by allowing sufficient time between pouring castings.

Complete stovemaking equipment is wanted by the Portland Stove Works, Portland, Oreg., which recently erected a new plant, 150 x 600 feet. This equipment includes, molding machines, nickel plating equipment, porcelain enamel equipment, etc., and the company also is interested in stove and furnace trimmings.

Electric Furnace Slag Reactions Outlined

"When properly installed and operated the electric furnace is metallurgically the best and most economical steelmaking apparatus we have," said L. B. Lindemuth, consulting metallurgist, New York City, in a paper delivered before the American Electrochemical society at its recent convention in Boston. Mr. Lindemuth deprecated undue claims for the electric furnace but set forth its many acknowledged advantages in considerable detail. He stated the heat of an electric furnace is neither oxidizing nor reducing and this means that it is possible to produce any melting condition desired, and in any necessary sequence.

In the first stage of the basic electric furnace process, oxidizing conditions are produced by the addition of oxygen in the form of iron ore. During this operation phosphorus, manganese and carbon are oxidized. The former two oxides are taken up by the slag, while the oxide of carbon goes off as a gas. The slag containing a large percentage of the phosphorus and manganese is removed from the furnace and materials are added to produce a second slag containing a high percentage of lime. Ground coke or coal is thrown on top of this slag to produce the necessary reduction. Reducing conditions brought about in this way are so strong that a calcium carbide slag is formed and silicon, vanadium, or other easily oxidized elements may be added to the metal in the presence of this basic slag without a great loss of the alloying metals.

In the acid electric-furnace process, the slag contains a percentage of oxides of iron and manganese in addition to oxides of calcium, silicon and aluminum. The acid slag is a complex calcium-iron-aluminum silicate which is itself oxidizing. Immediately after this slag is formed, it will tend to adjust itself to a certain degree of acidity, which is practically constant throughout the heat. Iron oxide cannot be reduced from this acid slag without being replaced by a stronger base. The best available base to use for this purpose is lime.

The electric furnace permits more flexibility in the application of processes and varieties of product than any other steelmaking furnace yet devised. This flexibility, however, requires a broad knowledge on the part of the operator, because of the many chemical reactions which take place in the furnace.

Manufacturing Chilled Iron Car Wheels - III

Molding Methods in the Wheel Foundry Are Unique

BY H. E. DILLER

EQUIPMENT for making cast iron car wheels necessarily is too heavy to be handled without the use of mechanical aids. This factor together with the character of the work which is dependent upon large repeat orders and the general uniformity of all car wheels has led to developing a special layout for car-wheel foundries. One of two basic designs usually is followed. The one most largely used is known as the straight-line and the other, the circular system. Besides these two systems there is another used in at least two car wheel foundries. This latter system which has been patented by C. W. Sherman will be described later.

Fig. 21 is a typical floor plan of a straight-line foundry. The position of the pig iron and coke storage in relation to the wheel breaker and the weighing scales may be noted. An industrial track immediately in front of the mixing ladle is used to carry the metal to the molding floors. On the opposite side of the foundry another track extends parallel to the hot metal track. Cars upon this second track are used to carry hot wheels to the annealing pits. Between these two tracks are the molding floors with straight lines of flasks. These flasks are never moved from their locations. A typical interior view of a straight-line foundry is given in Fig. 19.

Several systems are followed for handling the molds and the castings. One employs air hoists traveling on girders over each row of flasks. These hoists are pushed along by the molder to the places where he wishes to use them.

Another system utilizes an endless steel cable running high over each line of flasks. At one end of the line, the cable is wound over an idler pulley which may be moved forward and backward in a horizontal direction. At the other end it passes around another pulley or drum. The lower strand of the cable is looped around a pulley wheel connected to an axle of a buggy which is operated upon an overhead track about 12 feet above the floor. The cable then extends down toward the floor, makes a loop in which lays a sheave that holds a hook. It next is passed up again and over another pulley on the opposite axle of the buggy running on the overhead track. To move the hook up and down, the idler pulley at one end of the line is moved either forward or backward. This gives more slack in the cable when moved forward, and when moving backward it tightens on the cable and raises the hook. The motion of this idler is controlled either by compressed air or by a hydraulic ram. To move the buggy along the track, the drum at the opposite end of

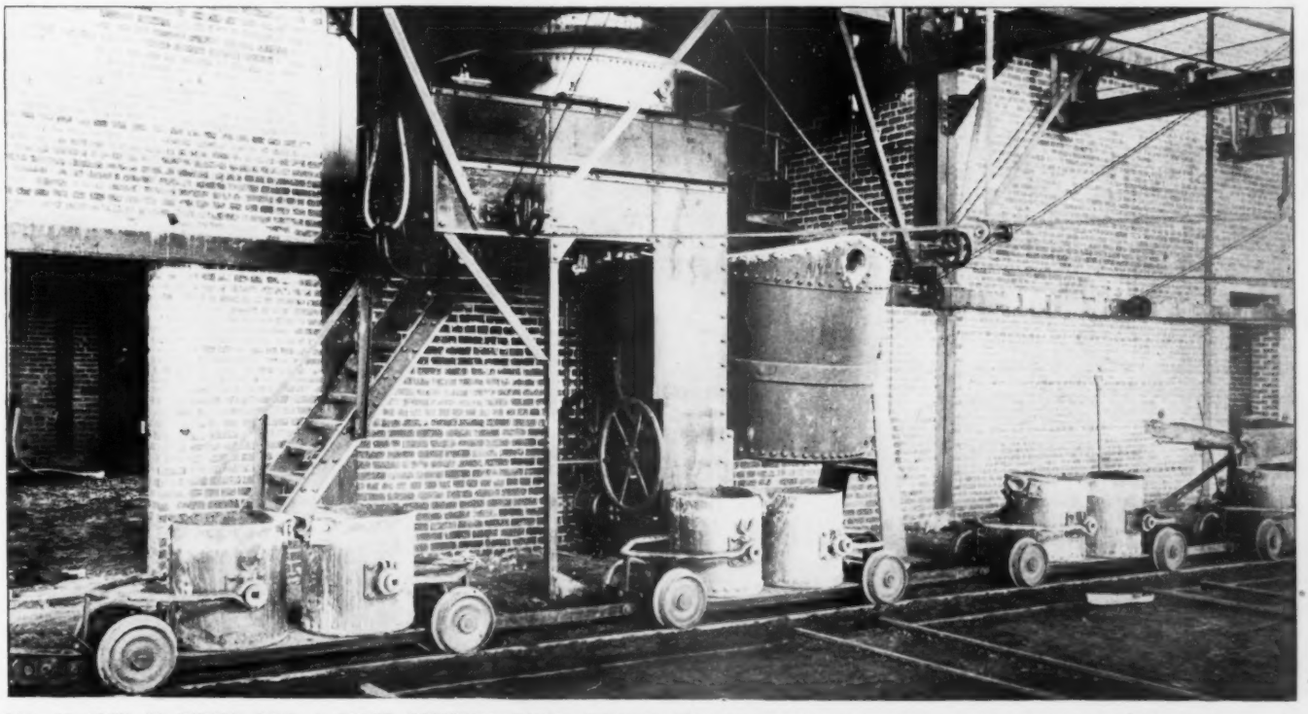


FIG. 18—IRON IS TAPPED INTO A LARGE RESERVOIR LADLE WHICH INSURES A THOROUGH MIXTURE—IT IS CARRIED TO THE MOLDS ON CARS HOOKED TOGETHER IN A TRAIN

FIG. 19—IN THE STRAIGHT-LINE SYSTEM MOLDS ARE ARRANGED IN ROWS—THE METAL IS CARRIED ALONG THE LINES OF MOLDS ON OVERHEAD TROLLEYS THAT EXTEND LONGITUDINALLY ALONG THE FLOOR

the line is moved against one of two revolving friction wheels. These wheels are on either side of the drum and revolve in opposite directions. Therefore, if it is desired to move the trolley one way on the tracks, the revolving wheel is brought into contact with the drum. To move it the opposite direction the wheel is brought into service. These wheels are operated by electric motors which are operated independently.

This type of a hoisting and conveying system is controlled, either by ropes which extend above the line of molds at about the height which a man can reach conveniently or by pairs of levers located along the line of molds. When levers are used, several pairs are placed along each line of molds so that the molder will not have to go far to operate the system.

The circular layout for car wheel foundries is illustrated in Fig. 20. Under this plan the molds are arranged in a circle on each floor around a jib crane. The metal is brought to the floor in ladles carried on a monorail and delivered to the molds by the crane. The same crane is used for handling the flasks and for carrying the hot wheels to the point from which a hook, carried by a trolley on a monorail can take them and carry them to the an-

FIG. 20—IN THE CIRCULAR SYSTEM OF FOUNDRY DESIGN METAL AND MOLDS ARE HANDLED BY A JIB CRANE SWINGING IN A CIRCLE

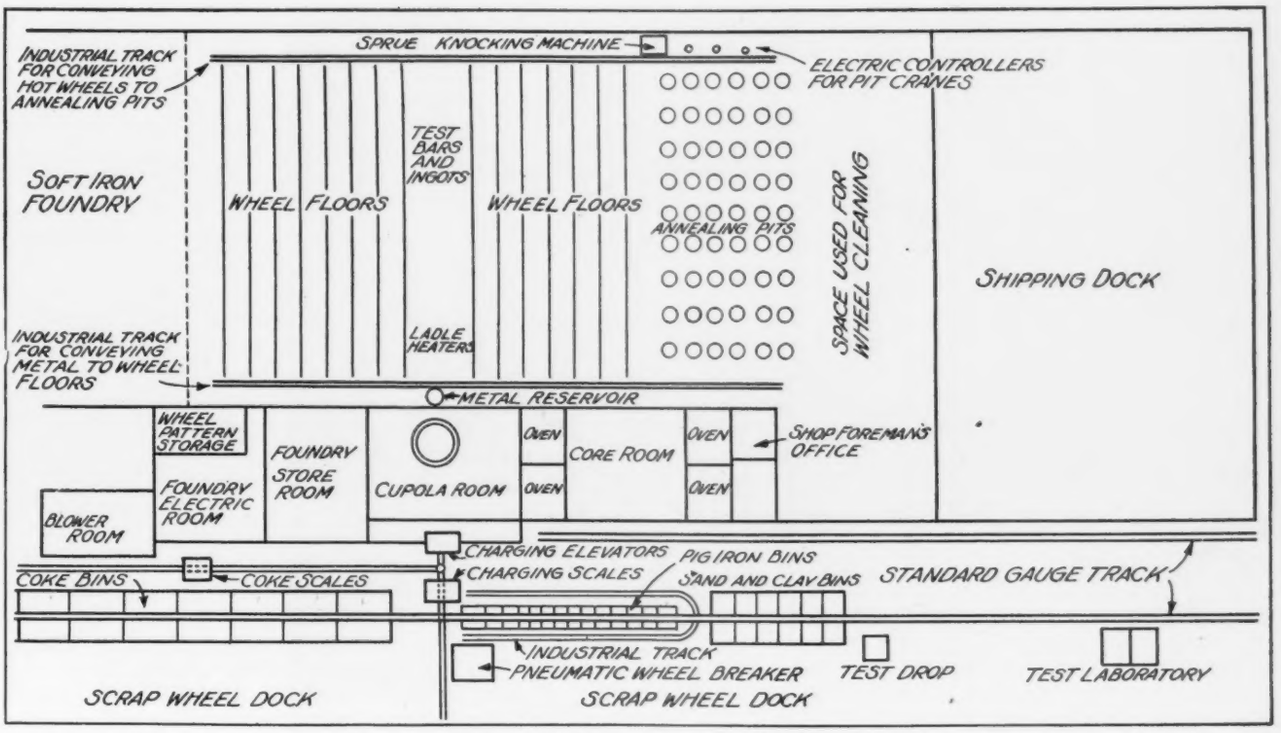


FIG. 21—THE FLOOR PLAN OF A WHEEL FOUNDRY SHOWS COMPACTNESS OF DESIGN—THE LINES OF MOLDS RUN BETWEEN THE HOT METAL TRACKS AND THE HOT WHEEL TRACKS

nealing pits. This arrangement is said to require more floor space per casting than does the straight line system.

Whichever system of handling is employed, the molding is similar. Before starting, the drag flask, chill and cope flask all are connected together by some clamping device. This assembly is placed so that the unbarred drag flask is bottom up. Then the pattern is laid in the chill with the flange side upward in the inverted drag as illustrated in Fig. 25.

A small button affixed to the pattern is placed adjacent to a line cut on the chill, to locate the pattern at the correct position so that the core prints and chaplets will be at the right location in the mold. The line and button are visible at the upper right edge in the illustration. This also shows the yoke used for handling the molds, by attaching it to the trunions on the side of the flask. After the drag is rammed, the bottom plate is placed on top and clamped to the mold. The whole assembly is then turned over. The dish core next is set on the core print in the center of the mold on the cope side. The block which forms the head is placed on the dish core, and the cope is rammed. To cope off, the chill is clamped with the cope and the two lifted. This leaves the pattern on the drag with the rim up. Two hand holes in the rim, as have previously been described, enable the molder to take hold of the pattern and draw it.

While the cope is held suspended by the hoist the gate block is taken out and the gate formed by hand. The molder also slicks the mold at this time, using specially shaped slickers to form the flange and rim. Two views of one of the flange slickers are shown at the left in the insert, Fig. 28. The rim slick is shown in two positions at the right in the same figure. The ring and center cores are set in the drag, and after the mold is closed and clamped it is ready to be poured.

The center core and disk core are held in their positions by the sand of the mold, but chaplets must be used to prevent the ring core from rising when the metal flows into the mold. Several methods for applying the chaplets are practiced. In the one method, pieces of 14-gage hoop steel, 1¼ inches wide are employed. These are cut to length and formed in a special machine. They then are placed in a wire-net

FIG. 22—CHAPLETS ARE SET IN LUGS ON THE COPE BARS AFTER THE COPE IS RAMMED—A GAGE ESTABLISHES THE CORRECT HEIGHT FOR THE CHAPLETS

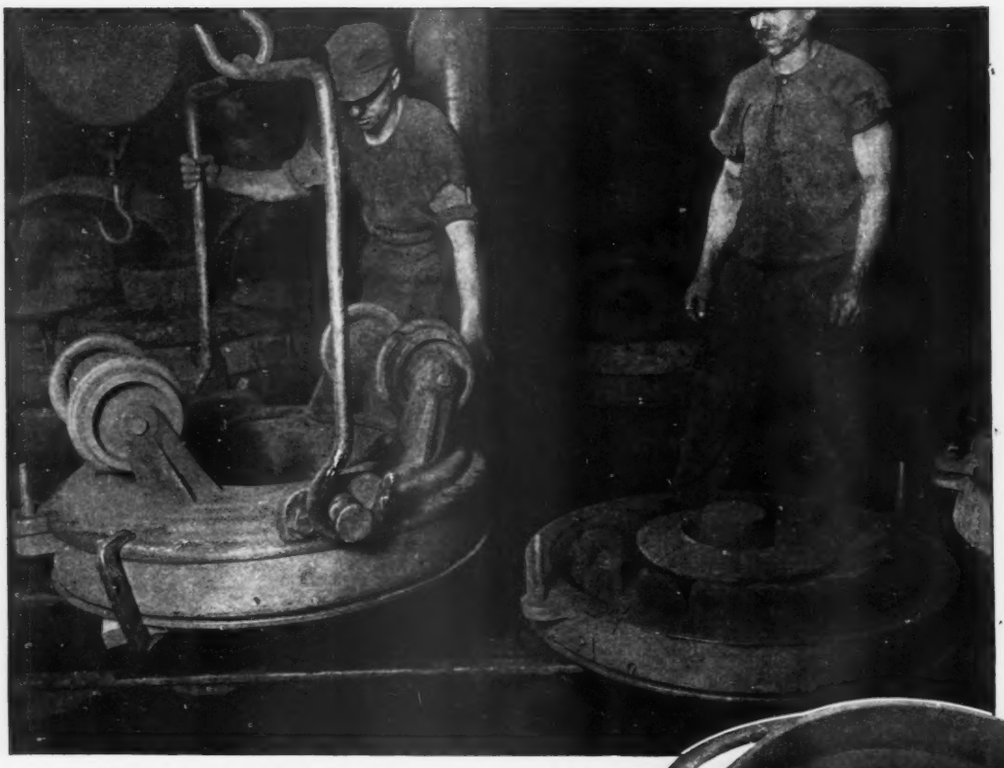


FIG. 23—ABOVE—A DRAG SECTION WITH THE CORES SET AND ANOTHER BEING TURNED READY FOR CORING. FIG. 24—AT THE RIGHT—A PATTERN IN THE CHILLER

basket and dipped in a tank of shellac. After being taken from the shellac they are allowed to drain until dry, when they are ready for use. One chaplet may be seen set in the core to the right of Fig. 24, which shows another chaplet being set. These chaplets must be placed exactly above the lugs in the cope flask. The design of the wheel also demands that the chaplets be placed opposite the core prints. To locate the chaplets, small grooves are cut in the circumference of the core plate. One of these may be seen in the rim of the plate opposite the chaplet which has been set. The chaplet is placed in an angle in a templet where it is held due to the slight spring in the chaplet which is bent at an angle larger than the recess or notch in the templet.

FIG. 24—CHAPLETS ARE SET WITH A GAGE—ONE END OF THE GAGE IS LOCATED BY A NOTCH IN THE RIM OF THE CORE PLATE AND THE OTHER END FITS IN THE CENTER

Some foundries use a templet to set three chaplets at one time. The chaplets are so arranged that they rest against lugs on the cope bars when the core is in the mold. A different method of adjusting the chaplets permits them to be placed in lugs on the cope bars. When this is done, the chaplet is in the form of a cast-iron knob with a stem which fits into a hole in the lug. Paper is wrapped around the stem to make it fit more securely. Fig. 22 shows the last of three of this type being set, and the gage which is employed to secure the correct height for the chaplet. In this particular case, the cast-iron chaplets were coated with a clay wash which prevented them from fusing with the iron of the casting. When it is desired not to coat the chaplets, they are molded each day and used the following day. They then are free from rust and after being tumbled may be used without a protective coating. Of course, it is necessary to see that the chaplets are not stored in a damp place or otherwise exposed to moisture. These cast-iron chaplets commonly are molded from match plates on which a number of patterns are gated.

While the use of molding machines for chaplets and cores is common the foundry that employs molding machines for making car wheel mold at present is exceptional. In one foundry stripping-plate machines are used for making the wheel mold. This method necessi-

tates a pattern for both the cope and the drag. The cope machine starts to work in the middle of the row and the drag machine starts at the end opposite to the one toward which the cope machine is working. In this way the cope always must be carried half the length of the line to reach the drag to which it is to be fitted. In the first operation of this system, the molder sifts sand over the surface of the drag pattern. Then the flask is filled with sand and rammed. While this is being done, another molder working on the drag is setting cores in the drag section previously made. The center core is set by a gage and the ring core by the prints. A drag with the cores all set is shown to the right in Fig. 23. The other molder has turned over the drag to which the bottom plate and pattern are clamped, and is setting it on the floor preparatory to drawing the pattern. In Fig. 26 the drag pattern is shown withdrawn.

FIG. 27—TEA-POT AND BOTTOM-POUR LADLES ARE USED TO PREVENT SLAG FLOWING INTO THE MOLD

While the drag section is being made the cope is rammed and the chaplets are placed. Then the cope is carried to the drag and the mold closed. Fig. 28 shows some chillers and cope flasks, to the left, and, to the right, the stripping-plate machine from which the cope has been lifted. Fig. 22 illustrates the cope section with the chaplets being set preparatory to closing the mold. It is thought that less skill is required of the molder with the stripping plate for drawing the pattern than when a loose pattern is employed.

The patented continuous molding system, which previously was mentioned, is the most elaborate so far introduced for making car wheels. One of the distinguishing features is the employment of sand conditioning equipment. All sand is carried to a mixer instead of being cut on the floor by the molders. This permits better control of the facing sand, but it has a disadvantage in that the sand may not always be tempered the same. The system is spoken of by foundrymen as the *merry-go-round*, because the molds are carried around a circle on buggies or cars. This circular track which carries the mold cars is 100 feet in diameter and accommodates 36 of the molding units.

Each of the cars used holds two molds. The drag and cope are made on separate patterns. Three of each are made at a time and closed together. The molds then are carried to the cupola where they are poured from a bottom-pour ladle handled by a jib crane equipped with an air hoist. After the iron has set, a little new sand is thrown on top of the molds to compensate for that which will be lost through sticking to the castings. The molds then are shaken out over a grating. The sand falls into a pocket from whence it is taken to the mixer by a conveyor. After being screened, mixed and tempered, the sand again is conveyed back to the molding sections; a portion to the drag molders and the remainder to the cope molders station. Meanwhile, the remainder of the system goes forward according to scheduled plans. After the heads are knocked off, the wheels are sent to the annealing pits. The flasks and chills are carried around the circle on the cars. At one station the hot chill is taken off and a cold chill is attached to the cope flask. All equipment is tight-

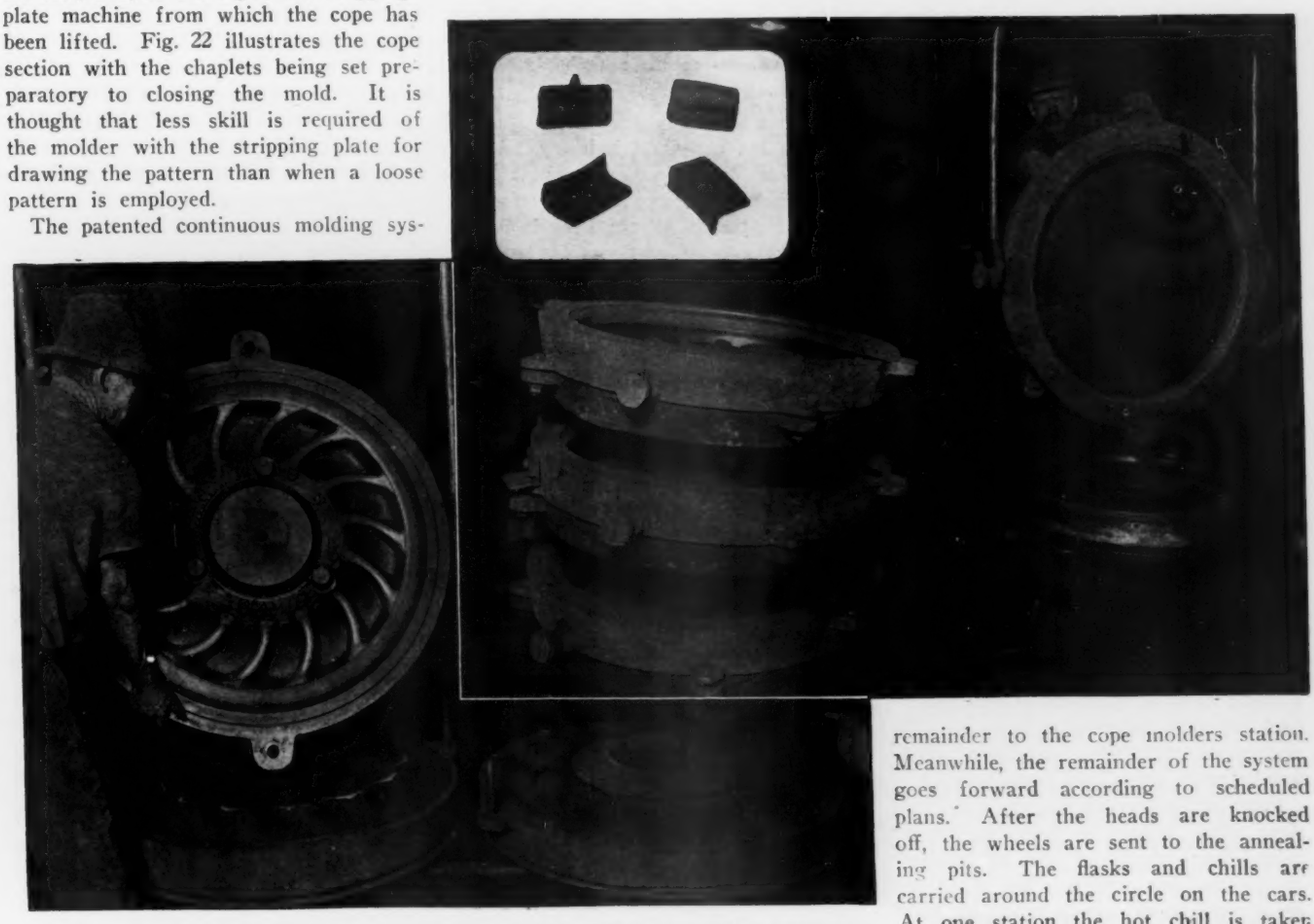


FIG. 26—ABOVE—THE HEAVY METAL PATTERNS ARE LIFTED WITH AN AIR HOIST FIG. 28—AT THE RIGHT—THE COPE IS MADE ON A STRIPPING PLATE MACHINE—THE INSERT SHOWS THE SLICKERS FOR RIM AND FLANGE

FIG. 29—AS SOON AS THE WHEEL IS TAKEN FROM THE MOLD THE SAND IS CUT AND THE FLASKS WITH THE CHILLERS ARE READY FOR ANOTHER MOLD

ened and inspected so that it is ready for the molders when it reaches them.

While this system has advantages in handling the sand mechanically and pouring at one point near the cupola, besides several minor points, the general plan of molding is similar to a number of other foundries. So far no foundry has perfected a molding machine entirely suitable for this system but a number of foundries are at present experimenting along this line. The machine thought most efficient is one which operates on the jar ram principle. A foundry which is experimenting with this machine has found it advantageous to move the cope bars near to the pattern. Bars also are placed in the drag. The main advantage of this machine consists in mechanically ramming the mold, but this is not a difficult operation to perform by hand. The machine is difficult to move around and therefore must be kept stationary. This requires the flasks and sand to be brought to the machine. In doing this the sand should be run through a screen, mixed and tempered, which is an advantage if regularity is secured in the tempering. The scope of the molding machine problem is better realized when it is remembered that the equipment and sand for one wheel weighs more than 2000 pounds.

From the nature of the operation it is clear that relatively little is to be gained per wheel by the introduction of the molding machine, but when the great number of wheels made by some of the larger foundries is considered, the total gain, possible through the development of a system based on the use of the molding machine, is seen to be large. The fact that there are car-wheel foundries with large production enables a considerable amount of experimentation and research to be undertaken which could not be attempted by a small company.

Pouring methods are fairly standard through the car-wheel industry. As has been mentioned, iron usually is taken from the cupola into a large reservoir or mixing ladle. From here it is carried to the molding floors in ladles of approximately 1000 pounds capacity, set on cars. A view of a typical reservoir ladle with its delivery or *hot train* is shown in Fig. 18. Generally this ladle is tilted by worm drive actuated by an electric motor. The operator who tilts the ladle also controls the hot train, which is propelled by a motor-operated cable. All cars are attached to the same cable so that when one moves all do. In this way all ladles are filled before any of them are taken to the molding floor. Then all ladles go to the molding floors together. In this particular case two ladles go to the same floor, as may be noted from the fact that each car holds two ladles. The tracks on which a line of flasks will be placed are shown running in from the bottom of the illustration at right angles to the hot-metal tracks.

Three styles of ladles are used in the different foundries: the ordinary ladle from which the metal is poured over the lip, the tea-pot ladle, shown in Fig. 27, and the bottom pour ladle. The stopper and nozzle of the bottom pour ladle in car-wheel foundries do not have to withstand the heat and abrasion to which steel ladle nozzles are subjected. For this reason, some foundries make fireclay nozzles in the core room and save the expense of the burnt nozzles. A detailed description of stoppers and nozzles of this type was given in the March 1 issue of THE FOUNDRY.

Iron is poured *hot*, or at least at a temperature which the car wheel manufacturer designates by this term. However, the manufacturer of automobile cylinders would say that the metal was too cold for good results. The difficulty of obtaining really hot metal may be realized when it is considered that

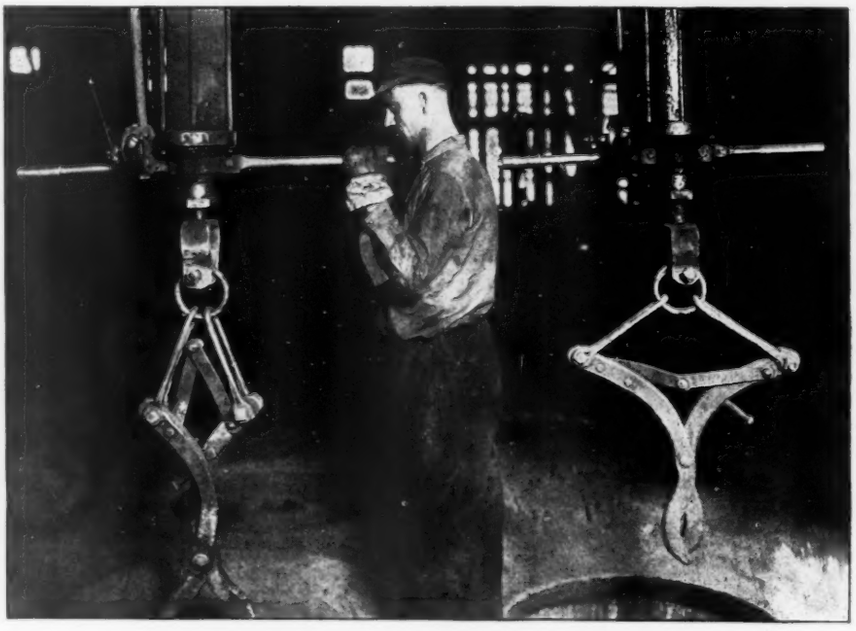


FIG. 30—MANY VARIETIES OF GRAB HOOKS ARE USED FOR PICKING UP THE WHEELS—THIS ONE ATTACHES TO THE INSIDE OF THE HUB

the metal is held in the cupola until 10,000 to 16,000 pounds have accumulated. After this, some of it must be held in the mixing reservoir while the first part is being poured. However, it may be judged from the emphasis put on hot iron by the manufacturers that there is constant danger of allowing the iron to become so dull that defective castings result. Cold iron causes rough and wrinkled treads. Iron, cold from the cupola due to oxidation, will give a deeper chill than iron, poured at the same temperature, but cooled from standing in the ladle.

Pouring Timed Closely

Considerable attention is paid to the length of time required to fill a mold. The cross section of the gates is so calculated that pouring a mold will require from 10 to 14 seconds depending upon the weight of the wheel.

As soon as the iron in the wheels have set, the flasks including the chillers are lifted and shaken out. The wheels are next lifted out of the sand and that which adheres loosely knocked off. Then they are carried to the *hot-wheel* train and placed on cars which convey them to the annealing pits. Before a wheel is sent to the annealing section, the head is knocked off and sometimes the sand in the bore is gouged out with a bar having a specially formed end. This end comes to a point and has a wing-shaped projection standing at right angles to the length of the bar a few inches from the point.

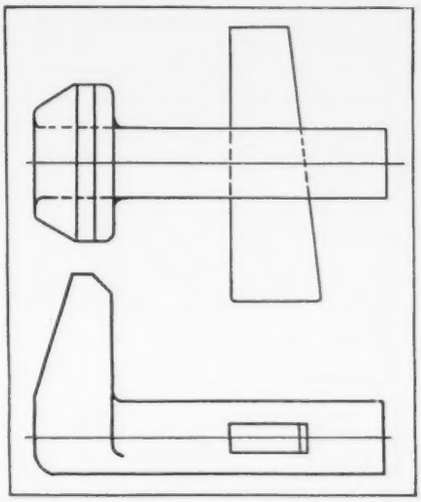
After a wheel is lifted off a bottom plate, the remaining sand is pushed clear of the plate with the back side of a shovel. The plate then is lifted and the flask is set in its place. Then two buckets full of water are thrown on the sand, which is cut by the molders into a long pile alongside the flasks. A row of sand and flasks is illustrated in Fig. 29. The bottom plates may be noted leaning against the flasks along the row. This floor is ready for the molder to start work on in the morning. The first thing the molder does in the morning is to cut the sand over again. He is then prepared for molding.

Wheels are handled by different designs of automatic grab and release hooks. Some of these grip the wheels at the rim while others stick through the hub and hold the wheel by expanding against the sides. A pair of the latter holders hanging on pneumatic hoists is shown in Fig. 30. The holder to the right is in position to engage a wheel. When the end of the holder is in the bore of the wheel the operator pulls up the two cross pieces and the prongs on the end expand until they strike the sides of the hub. The stronger the pull on them the more they will have a tendency to expand, and so the tighter is their grip on the wheel.

Steel Clamping Dogs

By George W. Childs

A cast steel clamping dog designed for clamping flasks and match plates together is shown in the accompanying illustration. It may be made in any size for large or small flasks and in fact can be used for clamping together two pieces of any kind of material. It consists of a one piece casting having a round shank and a square flat head. A narrow rectangular keyway is provided in the round shank at a suitable point for the



THE CLAMP IS TIGHTENED BY THE INSERTION OF A TAPERED STEEL KEY

work it is intended to be used on. A flat, tapered key which may be a steel forging for the larger sizes and may be stamped or sheared from steel plate of suitable gage for the lighter clamps, is used for producing the necessary tension.

The trouble experienced sometimes by the dogs or clamps slipping when rolling-over a flask is eliminated by the use of this device. The ordinary clamping arrangement simply provides for holding the match plate, drag, and bottom board in intimate contact while they are being rolled over. No provision is made to prevent either one of the three from working sideways should the wedges or clamps slip or become loose. In the device here shown the shank is made the same size as the pin holes in the flask and match plate. When the flask is rammed full of sand and the board set, one of these clamps is dropped through each pin hole; the keys are inserted and tightened by one tap from a hammer. On account of the shank of the clamp fitting the pin holes so closely there is no danger of the pattern plate working loose sideways in rolling the flask over. After the flask has been rolled over a single tap of the hammer will release the keys and the clamps may be removed.

The idea exemplified in this style of clamp may be adapted to many other uses than the one outlined. It could be used instead of bolts in binding copes and drags together; in fastening on bottom plates and for other purposes in which bolts generally are used. It is a notorious fact that bolts used around iron flasks in an iron or steel foundry are seldom employed more than a few times. The threads are either stripped or crossed and the bolts have to be thrown away. The clamps with the slotted hole and the keys should last indefinitely.

Extends Brass Works

Construction of a new 6-story building on an area 62½ x 84 feet fronting on Water street, will complete improvements and extensions which are being made by the McKenna Brass & Mfg. Co., Pittsburgh. In this addition the company plans to increase production of automatic bottle-filling machines and other lines for which it was unable to fully meet the demand with its former facilities. The foundry capacities of the company will be trebled by the addition. Equipment has been added to by the installation of several molding machines, an automatic sandblast machine and an electric melting furnace.

Link-Belt Co. Expands Plant Facilities

The Link-Belt Co., Chicago, is carrying out an extensive program of expansion at its works in Chicago, Indianapolis, Philadelphia, Seattle, and Toronto, Canada. Two new furnaces—the seventh and eighth—have been added to the chain works at Indianapolis in the last few months. Announcement of the purchase of the Fairmount Foundry, Philadelphia, was made recently. The foundry will be used as an adjunct to the eastern works at Philadelphia, supplying gray iron castings.

The General Casting Corp. has been organized in Pittsburgh to manufacture small gray iron, steel and nonferrous castings. The incorporators are W. E. Thompkins, George J. Frank, John N. O'Donnell, R. W. Hervey and W. V. Hoefer.

British Cupola Practice Outlined

Design of Cupola Modifies Charging Method—Limestone and Fluorspar Used as a Flux—Measurement of the Volume of Air Passing Through the Cupola is Advised for Best Results

BY R. R. McGOWAN

THE operation of a cupola is simple, that is, little knowledge is required to melt iron in the cupola and get fair results. However, in order to secure the most efficient melting, attention must be paid to many details which frequently are overlooked by the foundrymen. The first care to be exercised is the preparation of the cupola for a day's campaign. This preparation consists of chipping away any projecting pieces of slag which may have been left inside the cupola from the previous melt and repairing any unevenness in the lining with some refractory substance such as fireclay or ganister.

In a drop-bottom cupola, it is necessary to prepare the bottom each day by forming a bed of sand several inches thick on the doors after they have been closed. However, before the sand is introduced, the doors should be well damped with water, and the sand forming the bottom should be coated on the top with clay water to form a hard crust on the surface. There is a permanent bottom composed of several inches of ganister in the stationary-bottom type cupola. When the bottom has been arranged the spout is made up, then the tap hole is prepared and left open.

The cupola now is ready for the fire, which is kindled on the hearth with wood, access being obtained from a hole, generally in the back. Coke is placed around this fire and a wall of coke is built up in front of the access door. When the coke has thoroughly ignited, sand is tucked in front of this wall of coke and the iron door covering the access hole is wedged into position. During the kindling of the fire forming the bed all the openings, tuyeres, access door, etc., in the lower portion of the cupola are left open for the admission of air which is necessary for the combustion of the fuel.

Height of Bed

The bed of coke in the cupola serves to support the first charge of iron at the level of the melting zones. Subsequent charges of coke are introduced into the cupola between the charges of iron to make good the wastage of the bed due to combustion, and to maintain the bed at its original height during the day's operation.

As the object of the coke bed is to support the iron at the level of the melting zone, the level of the melting zone determines the height of the coke bed. The height of the melting zone varies in different cupolas owing to their construction. It also varies with the velocity and volume of air passed into the cupola, but the height may be fixed approximately at 18 to 24 inches above the top of the tuyeres.

The coke bed is charged in two portions. The first portion is brought up to the under side of the tuyeres and the remainder should not be added until the coke first charged becomes thoroughly ignited. This will be indicated when the flames are seen penetrating through the entire surface. To reach this stage may take from two to three hours after the cupola has been lighted, according to the diameter of the cupola. The remainder of the coke is then charged to bring the bed up to the level of the melting zone, namely 18 to 24 inches above the top of the tuyeres. When this is accomplished, the charging may be commenced. The pig iron, scrap, limestone and coke are charged in the order named and in the proportions which have been determined. The cupola should be charged to within 2 feet of the charging door before the blast is introduced and kept to that level through the melt.

The efficiency of a cupola depends to a great extent on the correct weight of metal placed on a charge. Within recent years the tendency has been to lower the amount making up a charge and the results have given satisfaction. The amount of iron which should constitute a charge is a question upon which many foundrymen differ. It is well to have the weight of the charge equal to 1½ pounds of iron per square inch of area of the cupola at the melting zone. The amount of coke to be placed on each charge is largely determined by the amount of iron on the charge. This is what is known as the *coke* or *melting ratio*. This ratio will vary with different cupolas, but the average ratio may be said to be 10 of metal to 1 of coke.

Slagging the Cupola

When large heats are run from the cupola some fluxing agent must be introduced. The function of the flux is to form a fusible slag by combining with the oxides from the charge and with any foreign matter such as sand and coke ash. This fusible slag then may be withdrawn from the cupola when desired. As a general rule, when the run of a cupola does not extend beyond two hours, slagging will be unnecessary. However, cases have occurred where it was necessary to slag a cupola before the first iron was tapped; the latter experience is exceptional and is only given to show the variation in the practice of slagging.

With a cupola melting 60 tons of iron for light castings per day, two slaggings is the usual custom, one after the cupola has discharged from 12 to 15 tons, and again the melt is about half through. When it is time to slag the cupola the iron is allowed to gather inside the well of the cupola until it reaches a little below the slag hole. The slag hole is then opened and the slag is allowed to run off. Care must be taken not to clear all of the slag from the face of the metal and thus expose the metal to the oxidizing effect of the blast. If this point is not observed bad castings may result. Should too little flux be used there is danger of the slag having insufficient fluidity to discharge itself from the cupola and it may tend to

CUPOLA practice abroad naturally differs in many essentials from established American custom. Contrasts may be noted even in the design of the European cupola as compared with our own furnaces. The author mentions the stationary-bottom which is no longer found in cupolas on this side of the Atlantic. The access hole described also is a novelty to American foundrymen who obtain access to the inside of the cupola, after the bottom doors are in place, by entering through one of the charging doors and descending to the bottom on a ladder which later is drawn away. Forehearths, which apparently are not commonly found in the British Isles, are a well established feature of cupolas in service throughout continental Europe.

The author, R. R. McGowan, is a past president of the Scottish branch of the Institution of British Foundrymen.

GROSS TON CONVERSION TABLES

Pig iron and scrap, two of the most essential foundry raw materials are bought and sold upon a basis of gross ton weight. Previous to the war, many grades of the latter were computed upon a net or 2000-pound ton unit, but through the influence of the government during and since the period of federal control, the gross ton has come to be the accepted standard for all classes of the commodities mentioned. The following tables, Data Sheets Nos. 331 and 332, give the equivalent weight in pounds from 1 to 340 gross tons. The decimal parts of a gross ton will be presented in tabular form in Data Sheets Nos. 333 and 334.

TABLE SHOWING VALUES OF GROSS TONS IN POUNDS

Tons	Pounds	Tons	Pounds	Tons	Pounds	Tons	Pounds
1	2,240	36	80,640	71	159,040	106	237,440
2	4,480	37	82,880	72	161,280	107	239,680
3	6,720	38	85,120	73	163,520	108	241,920
4	8,960	39	87,360	74	165,760	109	244,160
5	11,200	40	89,600	75	168,000	110	246,400
6	13,440	41	91,840	76	170,240	111	248,640
7	15,680	42	94,080	77	172,480	112	250,880
8	17,920	43	96,320	78	174,720	113	253,120
9	20,160	44	98,560	79	176,960	114	255,360
10	22,400	45	100,800	80	179,200	115	257,600
11	24,640	46	103,040	81	181,440	116	259,840
12	26,880	47	105,280	82	183,680	117	262,080
13	29,120	48	107,520	83	185,920	118	264,320
14	31,360	49	109,760	84	188,160	119	266,560
15	33,600	50	112,000	85	190,400	120	268,800
16	35,840	51	114,240	86	192,640	121	271,040
17	38,080	52	116,480	87	194,880	122	273,280
18	40,320	53	118,720	88	197,120	123	275,520
19	42,560	54	120,960	89	199,360	124	277,760
20	44,800	55	123,200	90	201,600	125	280,000
21	47,040	56	125,440	91	203,840	126	282,240
22	49,280	57	127,680	92	206,080	127	284,480
23	51,520	58	129,920	93	208,320	128	286,720
24	53,760	59	132,160	94	210,560	129	288,960
25	56,000	60	134,400	95	212,800	130	291,200
26	58,240	61	136,640	96	215,040	131	293,440
27	60,480	62	138,880	97	217,280	132	295,680
28	62,720	63	141,120	98	219,520	133	297,920
29	64,960	64	143,360	99	221,760	134	300,160
30	67,200	65	145,600	100	224,000	135	302,400
31	69,440	66	147,840	101	226,240	136	304,640
32	71,680	67	150,080	102	228,480	137	306,880
33	73,920	68	152,320	103	230,720	138	309,120
34	76,160	69	154,560	104	232,960	139	311,360
35	78,400	70	156,800	105	235,200	140	313,600

(*Concluded on Data Sheet No. 332*)

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note book form.

GROSS TON CONVERSION TABLES

(*Concluded from Data Sheet No. 331*)

TABLE SHOWING VALUES OF GROSS TONS IN POUNDS

Tons	Pounds	Tons	Pounds	Tons	Pounds	Tons	Pounds
141	315,840	191	427,840	241	539,840	291	651,840
142	318,080	192	430,080	242	542,080	292	654,080
143	320,320	193	432,320	243	544,320	293	656,320
144	322,560	194	434,560	244	546,560	294	658,560
145	324,800	195	436,800	245	548,800	295	660,800
146	327,040	196	439,040	246	551,040	296	663,040
147	329,280	197	441,280	247	553,280	297	665,280
148	331,520	198	443,520	248	555,520	298	667,520
149	333,760	199	445,760	249	557,760	299	669,760
150	336,000	200	448,000	250	560,000	300	672,000
151	338,240	201	450,240	251	562,240	301	674,240
152	340,480	202	452,480	252	564,480	302	676,480
153	342,720	203	454,720	253	566,720	303	678,720
154	344,960	204	456,960	254	568,960	304	680,960
155	347,200	205	459,200	255	571,200	305	683,200
156	349,440	206	461,440	256	473,440	306	685,440
157	351,680	207	463,680	257	575,680	307	687,680
158	353,920	208	465,920	258	577,920	308	689,920
159	356,160	209	468,160	259	580,160	309	693,160
160	358,400	210	470,400	260	582,400	310	694,400
161	360,640	211	472,640	261	584,640	311	696,640
162	362,880	212	474,880	262	586,880	312	698,880
163	365,120	213	447,120	263	589,120	313	701,120
164	367,360	214	479,360	264	591,360	314	703,360
165	369,600	215	481,600	265	593,600	315	705,600
166	371,840	216	483,840	266	595,840	316	707,840
167	374,080	217	486,080	267	598,080	317	710,080
168	376,320	218	488,320	268	600,320	318	712,320
169	378,560	219	490,560	269	602,560	319	714,560
170	380,800	220	492,800	270	604,800	320	716,800
171	383,040	221	495,040	271	607,040	321	719,040
172	385,280	222	497,280	272	609,280	322	721,280
173	387,520	223	499,520	273	611,520	323	723,520
174	389,760	224	501,760	274	613,760	324	725,760
175	392,000	225	504,000	275	616,000	325	728,000
176	394,240	226	506,240	276	618,240	326	730,240
177	396,480	227	508,480	277	620,480	327	732,480
178	398,720	228	510,720	278	622,720	328	734,720
179	400,960	229	512,960	279	624,960	329	736,960
180	403,200	230	515,200	280	627,200	330	739,200
181	405,440	231	517,440	281	629,440	331	741,440
182	407,680	232	519,680	282	631,680	332	743,680
183	409,920	233	521,920	283	633,920	333	745,920
184	412,160	234	524,160	284	636,160	334	748,160
185	414,400	235	526,400	285	638,400	335	750,400
186	416,640	236	528,640	286	640,640	336	752,640
187	418,880	237	530,880	287	642,880	337	754,880
188	421,120	238	533,120	288	645,120	338	757,120
189	423,360	239	535,360	289	647,360	339	759,360
190	425,600	240	537,600	290	649,600	340	761,600

THE FOUNDRY DATA SHEET, MAY 1, 1920
Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

accumulate around the tuyeres and prevent the proper melting of the iron. Too much flux will tend to destroy the lining of the cupola.

The two materials which have proved successful as fluxing agents are limestone and fluorspar. Limestone is most commonly used and forms a fairly good fluxing agent. The amount of limestone necessary for a charge varies from different causes, such as the composition of the iron, the amount of sand adhering to the pig iron and the ash contents of the coke. However, the average amount is about 45 pounds of limestone per ton of iron melted, being about 2 per cent of the iron charged. The amount of fluorspar necessary for a charge varies for the same reasons as the amount of limestone varies. The average amount is about 15 pounds of fluor spar per ton of iron melted.

Factors in Capacity

The melting capacity of a cupola depends upon three factors, namely, the diameter of the cupola, the volume of air passed into the cupola, and the pressure at which the air enters the cupola. Any formula which does not take each of these factors into consideration is not to be relied upon. However, very few cupola installations embrace any apparatus for measuring the quantity or volume of air entering the cupola. This is a defect which should be rectified, because until means are secured for determining and regulating the volume of air entering the cupola, little advance can be made with the study of cupola practice. F. J. Cook, Birmingham, England, made valuable investigations on this subject. The results of his research were embodied in a paper which he read before the British Foundrymen's association in 1913.

Mr. Cook found, from a number of experiments on different diameters of cupolas that the melting capacity of a cupola in tons (2240 pounds) per hour is equal to the product of air supplied in pounds per minute multiplied by the square root of the pressure of air in ounces and divided by the constant 120. Mr. Cook also found that the maximum possible rate of successful melting is obtained when the square root of the pressure of blast in ounces per square inch, multiplied by the quantity of blast in pounds per minute and divided by the diameter of the cupola in feet, equals 330. Another of Mr. Cook's determinations is the method of ascertaining whether a cupola is working to its maximum capacity. This was found to be true when the output in tons (2240 pounds) per hour multiplied by 120 and divided by the diameter of the cupola in feet equals 330. From this rule the following table showing the maximum melting capacity of cupolas has been calculated.

Maximum Melting Capacity Per Hour

Diameter of Cupola	Gross tons	Net tons
24 inches	5.5	6.16
30 inches	6.875	7.70
36 inches	8.25	9.24
42 inches	9.625	10.78
48 inches	11.00	12.32
54 inches	12.375	13.86
60 inches	13.75	15.40

While this table shows the maximum capacity, it is not considered advisable from an economical point of view to work a cupola up to its maximum capacity because of the effect which the blast has on the lining. Cupolas melting at a rate of about 2 gross tons less than their maximum might be taken as a fair average output. This would give the following melting rate.

Efficient Melting Capacity Per Hour

Diameter of Cupola	Gross tons	Net tons
24 inches	3.5	3.92
30 inches	4.875	5.46
36 inches	6.25	7.00
42 inches	7.625	8.54
48 inches	9.00	10.08
54 inches	10.375	11.62
60 inches	11.75	13.16

One of the factors entering into efficient melting in a cupola is the air supply, as has already been shown. The object of introducing air into the cupola is to bring a certain amount of oxygen into contact with the carbon in the coke and produce a heat-giving gas called carbon dioxide (CO_2). This gas is only produced when complete combustion is established.

The theoretical amount of air at 0 degrees Cent. that is necessary to burn 1 pound of coke to carbon dioxide (CO_2) is 129.06 cubic feet. Therefore, the amount of air passed into the cupola should not be less than this amount. One figure recommended is 135 cubic feet of air for each pound of coke charged. With a melting ratio of 1 to 10, this gives an average of 13.5 cubic feet of air per pound of iron melted, or 30,000 cubic feet of air to melt 1 ton of iron.

Theoretically, it is wrong to measure air passing into the cupola by its volume because of the fact that air expands 1/273 its volume for each degree of rise in temperature above 0 degrees Cent. However, the rise of temperature so far as it affects the cupola is little, and in order to simplify the subject this phase of the question is often neglected.

Calculating 1 cubic foot of air at 0 degrees Cent. weighs 0.0809 pound, and 1 pound of air at 0 degrees Cent equals 12.361 cubic feet, it is found from our previous statement that approximately 13.5 cubic feet, or 1.0921⅝ pounds of air are required to produce sufficient heat from coke containing 90 per cent carbon, to melt 1 pound of iron in the cupola.

The number of cubic feet of air per minute required for any cupola may be found by multiplying the melting capacity in pounds per hour by 13.5 and dividing by 60. The division by 60 is necessary because the melting capacity is figured per hour while the amount of air is determined per minute. To convert cubic feet of air at 0 degrees Cent. into pounds of air, it is only necessary to multiply by 0.0809.

The pressure of the blast is only one of the several factors which secures successful melting, and is no guide in itself. This pressure is modified by the freedom of the passage of air through the cupola and definite figures cannot be stated to cover all cupolas under all conditions. It may be measured by a pressure gage in ounces per square inch and also in inches of water column. One cubic inch of water equals 0.57856 ounce, therefore 1 inch head of water equals a pressure 0.57856 ounce per square inch. It follows then that the pressure of 1 ounce per square inch equals 1.7284 inches of water column.

Elects New Officers

At a recent meeting of the Debevoise-Anderson Co., Inc., 56 Liberty street, New York, Nils Anderson, president of the company since its organization, was re-elected to this office. C. A. Wyatt, manager of the Boston office of the company, was elected vice president. The resignation of Lieut. Col. Paul Debevoise as secretary and treasurer, was accepted. The new secretary is Charles A. Sleicher, who was president of the Troy Foundry & Machine Co., Troy, N. Y., and the new secretary is W. K. Callow, long associated with the Debevoise-Anderson Co. Lieut. Col. Paul Debevoise, who has become secretary and treasurer of the Matlack Coal & Iron Corp., still is financially interested in the Debevoise-Anderson Co. and remains a director in that company.

Removes General Offices

The general offices of the Chicago Pneumatic Tool Co. have been transferred to the Chicago Pneumatic building, a new 10-story structure erected for the exclusive use of the company at 6 E. Forty-fourth street, New York. The Chicago district sales branch of the company has been moved to 300 N. Michigan Boul., Chicago.

The Carborundum Company of Niagara Falls, N. Y., is planning extensions to its plant at Niagara Falls, and also to its furnace plants, one at Niagara Falls, Ont. and the other at Shawinigan Falls, Que.

Electrical Melting of Alloys - V

Indirect Arc Types Have Been Demonstrated as Successful Upon Nonferrous Alloys Containing Under Twenty Per Cent of Volatile Metals —Lining Economy Shown

BY H. W. GILLETT

IN THE previous article it was shown that the excessive temperature under the arc in a direct arc furnace caused local superheating and excessive loss of volatile metals when melting alloys high in zinc or lead. It also was demonstrated that while direct arc furnaces are in commercial use on alloys high in lead, they are used regardless of an increased metal loss as compared with crucible melting, not because of a decreased loss. Further it was pointed out that no direct arc furnaces are in use in America on yellow brass. The applicability of the standard direct arc type of electric steel furnace to nonferrous melting being thus limited, one must seek further for the solution of the brass melting problem.

The only other electric furnace that has much of a foothold in the electric steel industry under American conditions is the indirect arc type, operated with the furnace stationary.

The indirect arc furnace does not make an arc directly with the charge, but draws an arc or arcs between two or more carbon or graphite electrodes placed above the charge. Therefore, the source of heat is farther removed from the charge, and the transfer of heat to the charge is less direct. The fundamental principle has been stated that the closer the source of heat is to the charge, the better the thermal efficiency of the furnace. Therefore, it is plain that the basic design of a stationary indirect arc furnace makes it somewhat less efficient than a direct arc furnace.

However, one electrical advantage is gained. As the cold charge melts down in a direct arc furnace, the charge falls away from the arc and breaks the arc, which has then to be started again. This causes a continual surging of current, due to breaking and making the arc.

Indirect Arc is Steady

With an indirect, or *free-burning* arc, the arc is not affected by the position of the charge and is steady, even during the melting-down period. In late forms of the Rennerfelt indirect arc furnace for steel, Hamilton & Hansell, Inc., New York, the electrodes are made movable so that the arc can be free-burning during the melting down period, and may thereafter be drawn direct to the bath, by pointing the electrodes downward. This gives the better thermal efficiency to the direct arc type during the latter part of the heat. This modification is of no value for nonferrous alloys with volatile constituents, as the advantage of the indirect arc type lies in avoiding direct arcing to the bath.

There are two well known makes of indirect arc furnace, the earlier being an Italian furnace, the Stassano*, which,

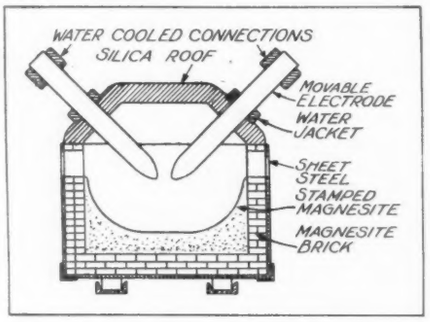


FIG. 1—CROSS SECTION OF STASSANO FURNACE, SHOWING THE INDIRECT ARC PRINCIPLE

together with Bassenese** and Angelini furnaces, which are practically identical in principle with the Stassano, has found wide use in Italy for melting steel. However, this type has been used but little in this country, as only one Stassano furnace is now in operation here. The other type is the Rennerfelt***, a Swedish furnace, which, outside of Italy, has the leading position among indirect arc steel furnaces.

The Stassano furnace may be made in single-phase form, with two electrodes, or in three-phase, with three. Fig. 1 shows the principle of the single-phase form, and Fig. 2 shows the arrangement of the electrodes in the three-phase form. Commercial Stassano furnaces are three-phase. The arc in the Stassano is made between the charge and the roof and heat is radiated both up and down. All three electrodes enter from the sides.

In the Rennerfelt furnace, two-phase current is used. This current is obtained from three-phase by the Scott connection, passing through three electrodes, the middle one of which enters through the roof and serves as a common path for the current in both phases. The other two electrodes enter from the sides. These connections and this arrangement of the electrodes, shown in Fig. 3, cause the arc to be deflected downward toward the charge and the shadow of the middle electrode prevents the direct heat of the arc from reaching the center of the roof. This arrangement tends to give a longer life to the roof than does the Stassano electrode plan.

Fig. 4 shows a lip-tilting Rennerfelt; Fig. 5 one tilting on trunnions; and Fig. 6 shows two Rennerfelt nose-tilting furnaces which are used for melting cupronickel, coinage silver, and coinage bronze at the Philadelphia mint.

The first question that arises in the consideration of indirect arc furnaces for brass is their applicability to alloys high in zinc.

Schmelz* has described the Stassano-Petinot** furnace, a modification of the Stassano furnace, designed for nonferrous alloys, one of which is scheduled to be in operation in 1920. Hansen*** has described the single-phase Weeks**** indirect arc furnace, designed for smelting zinc.

Both Schmelz and Hansen cite results of single heats of copper in these furnaces, and discuss the possibilities on brass, but no actual tests on brass were made in these furnaces.

Shows High Loss on Borings

Hansen, at the General Electric works, Schenectady, N. Y., in 1913-1914, constructed a three-phase, 2-ton Stassano type furnace and tried it on yellow brass borings. There was notable surface overheating, much zinc fume escaped, the metal loss was high, and

*Stassano, E., U. S. Patents, 799,105; 1,024,657; 1,059,499; 1,105,859.

**Bassenese, F., English Patent, 1,173 of 1915.

***Rennerfelt, I., U. S. Patent 1,076,518.

*Schmelz, E. M., Electric Furnace for Medium Temperatures, Trans. Am. Inst. Metals, Vol. 8, 1914, p. 261.

**Stassano, E. and Petinot, N., U. S. Patent 1,093,494.

***Hansen, C. A., Electric Melting of Copper and Brass, Trans. Am. Inst. Metals, Vol. 6, 1912, p. 110.

****Weeks, C. A., U. S. Patent 949,511; Melting Non-ferrous Metals in an Electric Furnace, Met. and Chem. Eng., Vol. 9, 1911, p. 363.

the furnace was adjudged unsatisfactory for yellow brass. The charge contained 33 per cent zinc and the product only 27 per cent.

The Scovill Manufacturing Co., Waterbury, Conn., also tried out a Stassano-type furnace on yellow brass, but encountered surface overheating, loss of zinc and trouble from condensation of zinc vapor on the electrodes. The company soon abandoned the furnace.

The bureau of mines built a 100-pound, 35-kilowatt, single-phase, Stassano-type furnace in 1913, and on a run of 800 pounds of 30 per cent zinc yellow brass ingot, poured at 1050 degrees Cent., obtained a net metal loss of 2.8 per cent. On a run of 700 pounds of ingot (78 per cent copper, 4 per cent lead, 18 per cent zinc) poured at 1100

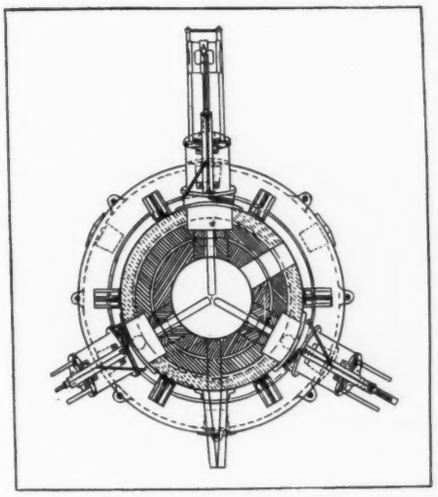


FIG. 2—PLAN OF 1-TON, THREE-PHASE STASSANO STEEL FURNACE

degrees Cent. a net loss of 2.4 per cent was noted. In this small unit it was possible to keep the furnace tightly closed while melting, so that no zinc fumes escaped. However, the charge became noticeably superheated on the surface, even though the bulk of the melt was scarcely hot enough to pour, so that when the furnace was opened for pouring a long stream of zinc vapor shot out, burning in the air with a blinding light and a hissing noise. The metal loss, while smaller than in a direct arc furnace, still was greater than in fuel-fired crucible practice. Yellow brass borings gave even greater trouble and loss.

The early accounts* of the Rennerfelt furnace stated that it had been applied to yellow brass in Sweden, so further information was sought from its agents. In reply it was stated that in a 60-kilowatt furnace working on charges of around 200 pounds, starting with a fully hot furnace, copper was melted at the rate of 290 kilowatt hours per ton and 60:40 brass, made from new metals, at under 250 kilowatt hours per ton. The metal loss on the 60:40 brass was about 3½ per cent. Swedish data presented in 1916 on a 50-kilowatt, 600-pound furnace at the Nordiska Armatur Co. showed a metal loss of from 4 to 6 per cent on 60:40 brass and a power consumption (furnace hot *i.e.*, 24-hour basis) of 225 kilowatt hour per ton. A similar furnace at the Atvibaberg Co., working on red brass, averaged 365 kilowatt hour per ton with a metal loss under 1.5 per cent. The hours per day of operation were not stated.

In a 1200-pound furnace on pure copper (probably 24-hour operation) the average power consumption on a 250-ton run was 365 kilowatt hours per ton, the gross loss 0.86 per cent (which was mainly dirt on the scrap copper charged) and the electrode consumption, with carbon electrodes instead of the usual graphite ones was 10 pounds per ton.

Nonvolatile Metals Melted

A 100-kilowatt, 650-pound Rennerfelt furnace is installed at the Gerline Brass Foundry Co., Kalamazoo, Mich. This furnace is used on jobbing work, never on more than 10-hour operation, and has seldom been called upon for the greatest output of metal it could produce if pushed. It has been used on monel metal with satisfactory results, the product being of good quality and the metal loss practically zero. On account of the small size of the furnace and its intermittent operation, the power consumption on monel is rather high. A 500-pound heat takes about four hours if it is the first heat of the day, and consumes about 1200 kilowatt hour per ton. Pure copper, in a hot furnace is melted at about 500 kilowatt hour per ton with a metal loss of about 0.20 per cent.

On some 4 tons of red brass, from scrap, gates, ingot and new metal, the gross metal loss was 2.3 per cent, no deduction being made for metal in slag or spillings. The coke fire gross loss on this charge at this plant is given as 4 per cent. If the furnace is run without being hampered by delays due to causes outside the furnace, this small Rennerfelt on 9-hour operation should give an output of about 1½ tons at about 480 kilowatt hours per ton or, on 24-hour operation, about 5 tons at about 380 kilowatt hours per ton. The consumption of graphite electrodes is about 3½ pounds per ton.

On about 7 tons of an alloy made up of half red scrap, gates or ingot and half yellow ingot, thus containing in the neighborhood of 20 per cent zinc, the gross loss was 2.5 per cent against a coke-fire gross loss of 4.5 per cent. On 1700 pounds of borings of this alloy the gross loss was 4.6 per cent in the electric furnace.

On two heats of clean yellow ingot (36 to 40 per cent zinc) the gross electric furnace loss was 4 per cent against a coke-fire loss of 3.5 per cent.

On a heat of all yellow borings, even though the charge was only 308 pounds, in order to keep the charge away from the arc and though the power input was dropped to 60 kilowatt to minimize overheating, the furnace could not be kept tight. A flame of zinc vapor 3 feet long blazed forth from the spout, and only 153 pounds could be poured. The remainder was partly

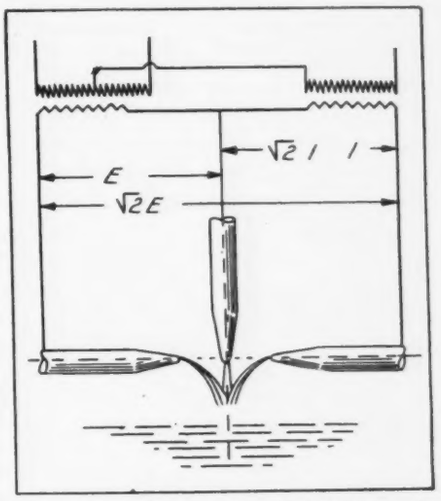


FIG. 3—CONNECTIONS AND ARRANGEMENT OF ELECTRODES IN RENNERFELT FURNACE

volatilized and partly held in the powdery dross.

Much trouble was met in melting the alloys high in zinc—even the 20 per cent zinc alloy—due to zinc vaporizing and condensing on the electrodes. This zinc on solidifying soldered the electrodes into the furnace walls or the electrode coolers and made them stick so they could not be moved to adjust the arc. The sticking caused much electrode breakage.

In 18 consecutive heats on the 20 per cent zinc alloy, nine electrodes were broken from this cause. According to the user, the furnace does wonderful work on monel metal, excellent work on copper and red brass, operates fairly well on the 20 per cent zinc alloy, but should not be recommended "under any circumstances to anyone" for yellow brass much above 20 per cent zinc. On one heat, made at this plant on an alloy high in lead, the last few castings from the last ladle were almost pure lead. The trouble had to be

*Anon. A Small-size Electric Arc Furnace, Met. and Chem. Eng., Vol. 12, 1914, p. 275.

overcome by careful stirring. The general quality of the metal is "just as good as that from pit fires."

This furnace has a ganister hearth, silica sides and a carborundum brick roof. The roof showed little wear after 400 heats.

The Philadelphia mint obtains a net loss of 1/100 of 1 per cent in Rennerfelt furnaces on coinage silver (90 silver, 10 copper). The loss is about 0.25 per cent on cupronickel (75 copper, 25 nickel) and 0.50 to 0.75 per cent (though with the most careful operation it can be kept down to 0.30 per cent) on coinage bronze (95 copper, 5 tin and zinc, usually around 4 tin, 1 zinc). The mint states, however, that an excessive loss would be expected on alloys high in zinc.

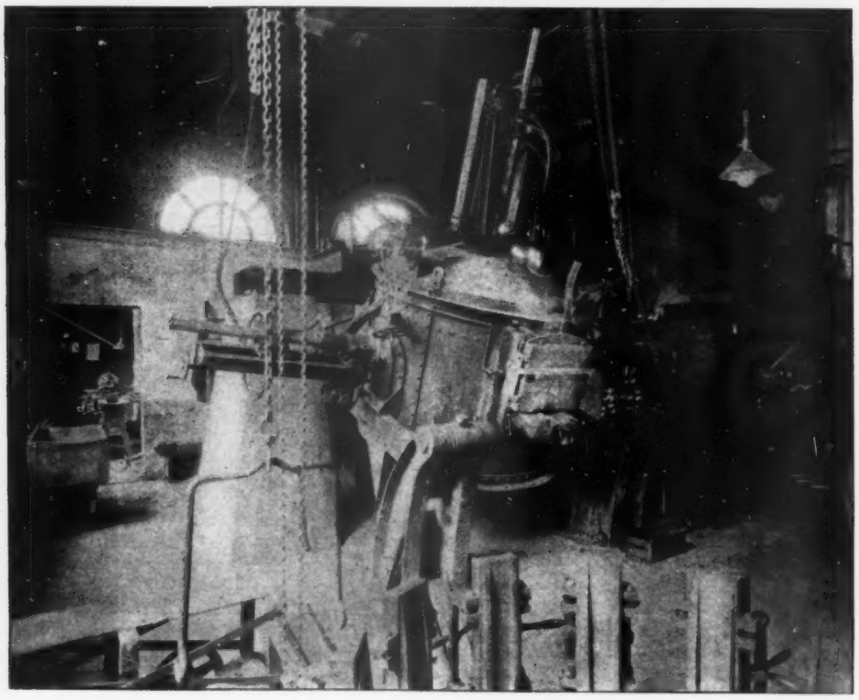


FIG. 4—LIP TILTING TYPE OF RENNERFELT NONFERROUS FURNACE

On alloys low in zinc, we see that the indirect arc furnace makes possible considerable metal savings even over good crucible practice. As the zinc content rises, the loss increases, so that at 20 per cent zinc the loss is about equal to that with crucible practice, but rises above it on true yellow brass. However, by going from the direct arc to the indirect arc type, the maximum zinc content allowable has been brought up from some 5 per cent to 20 per cent.

The French use of a direct arc furnace on yellow brass was because of fuel shortage coupled with the availability of hydroelectric power. Under governing conditions, the high zinc loss was a minor factor. In a similar case reported from Sweden, the indirect arc furnace has been used on a similar alloy on account of the high cost of fuel compared with the hydroelectric power. The analogy goes even farther. The French direct arc furnace held 2¼ tons per heat and was given a power input of only 175 kilowatt. Similarly in the Swedish indirect arc furnace, which held nearly 1½ tons per heat, the power input was held down to an average of 110 kilowatt. This low power input, which was used to secure greater equalization of heat in the furnace to minimize surface overheating and thus to hold the metal loss down, resulted in low production and a high power consumption per ton, considering the low melting point of the alloy, the large size of the furnace and the continuous 24-hour operation in both cases.

The test in Sweden was made in a Rennerfelt furnace, which was at full operating temperature at the start of the test. The furnace was run 23 hours per day, being shut down one hour at midnight. In 38 hours (36 hours running time with two midnight periods) less than 11½ tons were melted, the output being less than 1/3-ton per running hour. The electrode consumption was 4¾ pounds per ton, jointed carbon electrodes being used instead of graphite, which are exclusively used in American practice on the Rennerfelt furnace. This test was made in June, 1919.

The material melted was scrap brass of 42-45 per cent zinc, and 110 pounds extra zinc was added to each 2750 pounds scrap charged to make up for the zinc loss. That is, 4 per cent of the weight of the charge was calculated to be lost and required replacement. The net loss by weight is given as 2½ to 3 per cent, after deducting nonmetallic impurities in the charge and allowing for metal in slag and spillings. The power consumption averaged 304 kilowatt hours per ton.

Two other types of furnace, under this same schedule of operation on this alloy would have given better results. A 60 kilowatt furnace of one type would give as great an output per hour, would use less than two-thirds the energy per ton, and would give less than 1 per cent metal loss. Another type, a 1-ton 300 kilowatt furnace, would give three times the output, would use less than three-fourths the energy per ton, and also would give a metal loss of not over 1 per cent.

However, coke is so high in Sweden that it would have cost $15 to $20 per ton of metal melted, against $3 or less for electric energy per ton melted. This saving in fuel and in the cost of crucibles, made it possible for the indirect furnace to melt more cheaply than a coke fire, even though the metal loss was excessive.

Under American conditions, the indirect arc furnace can hardly compete with fuel-fired furnaces on yellow brass, and certainly cannot compete with other types of electric furnaces that are suited for use on yellow brass. The American agents for the Rennerfelt furnace realize this fact, and do not advocate it for American use on yellow alloys. If this type is confined to use on alloys of not over 20 per cent or, still better, not over 15 per cent zinc, it does good work, and for such use, has been found satisfactory.

Two 1500 to 2000-pound capacity 300 kilowatt Rennerfelt furnaces have been in use at the Chicago Bearing Metals Co. since 1917, melting a leaded bronze of 70-75 per cent copper, 15-20 per cent lead, about 6 per cent tin, with small amounts of iron, antimony and zinc as impurities. This alloy is poured at about 1150 degrees Cent. On 20-hour, two-shift operation during a test in 1917, these gave 10 to 11 tons per furnace per day at about 285 kilowatt hours per ton. Considerable trouble was met from electrode breakage. The furnaces required 3-inch diameter graphite side electrodes, the middle electrode being 4-inch in diameter. The electrodes passed through bronze water-coolers, and the volatilized zinc and lead, and oxides of these metals, collected on the electrodes within the coolers, causing them to stick and break. The actual electrode consumption ran about 5½ pounds per ton and about 2 pounds more per ton additional were lost through breakage.

The use of the water-coolers mentioned was abandoned in 1918 and the electrodes were passed through large 6 x 8-inch holes in the walls. This allowed much oxidation of the electrodes and weakened them so that they readily broke at the points. In 57 heats, 33 breakages occurred during one period in 1918. On changing from 3-inch to 4-inch side electrodes this breakage was lessened.

The large clearance about the electrodes prevented running the furnace tightly closed. For this reason, there is extra metal loss and a fume nuisance that has to be handled by ventilation, the same as with the Snyder furnaces operating on the same alloy at the same plant. The net metal loss on the leaded bronze in the Rennerfelts was found on test to be about 2¼ per cent, or slightly under the net loss on the same alloy, in crucibles.

The Rennerfelts at Chicago are lined with the same carborundum fire-sand, fireclay, molasses mixture as the Snyders and, like the Snyders, they have firebrick roofs. The hearths last for about 400 heats of 1500 pounds and the roofs, 100 to 180 heats, on 8-hour, one-shift operation.

In 1918, the Rennerfelts, on 19-hour operation were only giving about eight 1-ton heats per day and were using about 330 kilowatt hour per ton. These figures were not as good as the test figures of 1917, but the power input was held too low in 1918, being only about 200 kilowatt.

In 1919 the size of the heats was reduced to 1500 pounds, the power input brought up to about 320 kilowatt, and the furnace tenders were paid for a full day's work and allowed to leave no matter how soon they attained the standard number of heats. This arrangement results in getting eight heats, or 6 tons on one shift, 8-hour operation, and in reducing the power consumption to 320 kilowatt hours per ton, or less than that obtained on 19-hour operation in 1918. The Rennerfelt is not well adapted to mechanical charging, so that operation is slowed up by necessity for hand charging. However, the furnace is charged by two men in 5 minutes.

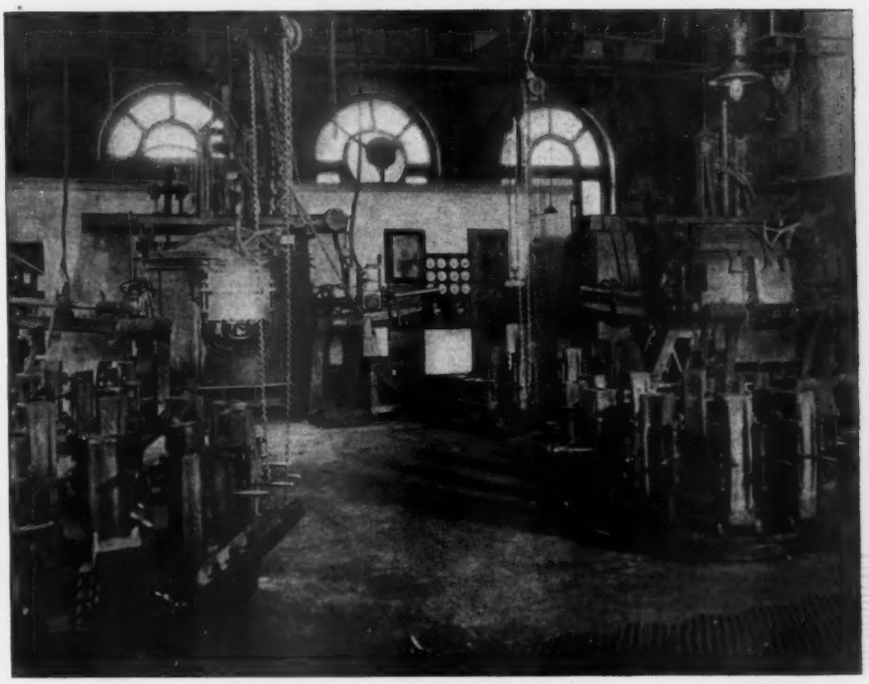


FIG. 6—TWO LIP-TILTING TYPE FURNACES INSTALLED AT THE PHILADELPHIA MINT

The power input of 320 kilowatt average, while the arc is on, is too high for the transformers, which heat up too much. For this reason the Chicago Bearing Metals Co. expects to drop the power input a little, even at the sacrifice of some speed and thermal efficiency. These furnaces have an average power factor of about 75 so that at 320 kilowatt the transformers, rated at 300 kilovolt amperes are giving 425 kilovolt amperes. This is too much of an overload.

Automatic electrode control has worked so well on the Snyders that the Chicago Bearing Metals Co. is contemplating it for the Rennerfelts also.

The Snyders give a greater production and a slightly lower power consumption than the Rennerfelts, because they take 400 kilowatt while the Rennerfelts take but 300. However, the Snyders give high metal losses and a power factor so low that they run into a power factor penalty on the power bills. It seems to be more or less of a toss-up as to the relative value of the two types on the alloy they handle under like conditions at the Chicago Bearing Metals plant.

The Rennerfelt installation at the Philadelphia mint* has shown that type of furnace to be extremely well adapted

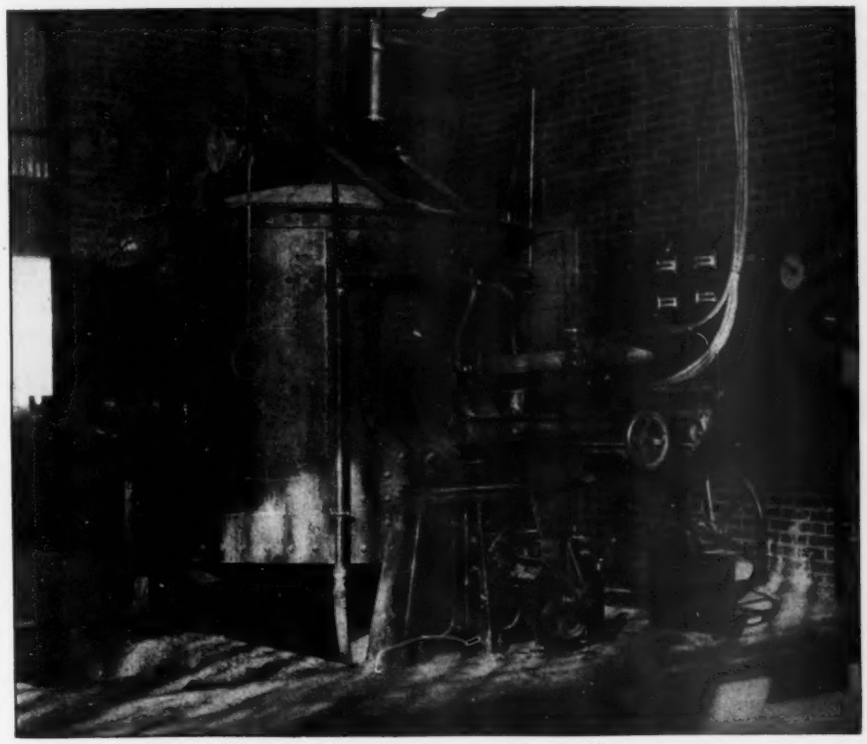


FIG. 5—TRUNNION TILTING TYPE RENNERFELT FURNACE—THIS IS A STEEL MELTING UNIT

*Compare Baker, R. T., Annual Report of the Director of the Mint for the Fiscal Year ending June 30, 1918, Treas. Dept. Doc. No. 2822, p. 11; Annual Report of the Director of the Mint of the Fiscal Year ending June 30, 1919, Doc. No. 2849, p. 12.

to the sort of work the furnaces have to do there. In July, 1917, a 1000-pound, 125-kilowatt, 110-volt trunnion-type Rennerfelt furnace, with hand-operated electrodes, was installed. It usually was operated 24 hours per day and in some 50 weeks of regular operation, produced over 1300 tons of cupro-nickel, bronze and silver coinage alloys. The average power consumption was about 300 kilowatt hour per ton on bronze, and about 200 kilowatt hours per ton on silver. These figures includes some 8-hour, as well as much 24-hour operation.

On cupronickel, 24-hour operation gave a daily output of 5 tons at 440 kilowatt hour per ton, and 8-hour operation, 1½ tons at 650 kilowatt hours per ton. The total melting cost on this alloy was less by 50 per cent than in the gas-fired crucible furnaces formerly used. On all the alloys together, the saving is 40 per cent. The output per furnace tender was doubled.

On coinage bronze, 24-hour operation gave 6½ tons to 7 tons output at 300 to 325 kilowatt hours per ton, while 8-hour operation gave 1¼ tons at 400 kilowatt hour per ton. This furnace, lined with silica brick and with a silica brick roof, gave nearly 1300 heats before relining, and roofs lasted from 800 to 1000 heats. Putting on a new roof is said by the makers to cost $60 on the 1000-pound and $85 on the ton size.

The furnace then was run on silver dollars and in melting 1585 tons (3191 heats) neither roof nor lining required replacement. The output was 9 tons in 24 hours and the power consumption was 177.4 kilowatt hour per ton under 24-hour operation. The cost for electric power was 50 per cent less than gas would have cost, for melting this lot of silver in gas-fired crucibles.

The lining and roof life was doubtless better on 24-hour operation than it would have been on single-shift operation. The consumption of graphite electrodes is 2½ to 4 pounds per ton of product, being lowest on silver and highest on cupro-nickel.

This furnace was replaced by another 1000-pound furnace of the nose-tilting type and with automatic electrode control. A second furnace, of similar type and similarly equipped, but of 1-ton capacity also was installed. This gave, on 24-hour operation on bronze, 9½ tons per day, at about 275 kilowatt hours per ton, and 3 pounds electrodes per ton. A 1000-pound furnace has been ordered for the San Francisco mint.

Although the nose-tilting furnaces were installed to allow pouring direct from furnace to molds, and although it was found possible to pour with precision, it was concluded that better ingots resulted through pouring from the furnace into a ladle and from that into molds.

Must Avoid Oxidation

One important point is brought out by the mint, especially in connection with cupronickel. The director of the mint says: "We are told, and assume, that the atmosphere of the furnace under heat is nonoxidizing. Results, however, have shown that every precaution must be taken to keep the surface of the molten metal covered if good non-oxidized ingots are to result. Should the furnace attendant neglect to keep the door closed and metal covered, oxygen of the outside air will, of course, cause trouble."

That is, it is desirable to operate an electric furnace tightly closed to keep the air out, even when there is no zinc in the charge to be kept in at the same time.

Prices quoted on this type furnace in February, 1920, including transformers, meters, switches, *i.e.* everything from the high tension line on, for 60-cycle current, were:

500-pound, 100 kilovolt amperes hand tilt, hand electrode control, $5280.

1000-pound, 150-200 kilovolt amperes, hand tilt, automatic electrode control, $12,000 approximately.

2000-pound, 300-500 kilovolt amperes, motor tilt, automatic electrode control, $16,000 to $20,000.

These prices refer to trunnion types. Larger furnaces are built at higher prices.

Indirect arc furnaces, operating stationary, show good reliability and thermal efficiency. They can be had to give a balanced three-phase load, and while any arc furnace will show some current surges, the surges are much fewer than in the direct arc type.

Indirect arc furnaces can operate with fair efficiency on single-shift operation as well as on continuous operation. They allow changing from one alloy to another in successive heats. They are not at all suited to melting yellow brass, but are thoroughly suited to the production of alloys with not much over 15 per cent zinc.

This type is a step in advance over direct arc furnaces, but it leaves the important yellow brass rolling mill industry, as well as the makers of yellow brass sand castings, still unprovided with a suitable electric furnace.

The types of electric hearth furnaces that are useful on steel are not suitable for brass, though they are suitable for bronze. Other and special types therefore had to be worked out for brass, and these will be described later.

How and Why in Brass Founding

By Charles Vickers

Smooth Aluminum

In making aluminum match plates we experience difficulty in getting a smooth surface between the patterns. After being finished the plates work perfectly, but the appearance is not satisfactory.

If the roughness is due to the use of too coarse molding sand, it can be avoided by using a thin layer of a facing of Windsor Locks sand. If the patterns are satisfactory, and only the plate is too rough, the facing need not cover the patterns. A sand that is fine in texture, but not clayey is required for molding aluminum. If the sand used is too coarse, the patterns will also be rough. Flour should never be dusted on molds for aluminum, but there is no objection to talc or soapstone. If the plate is faced with a fine sand and the surfaces are slicked after the pattern is removed, the castings will be smooth.

Brass For Gongs

We have to make a number of gongs and would like to obtain a formula for an alloy having a clear tone. We also would like to obtain the formula for a manganese bronze that will be ductile.

For bells and gongs of clear tone use the following mixture and flux. Mixture: Copper, 80 per cent; tin, 20 per cent. Melt the copper under a thick charcoal covering and when the metal

begins to sink down add a flux composed of yellow prussiate of soda, 1 pound; sharp sand, 1 pound; soda ash, 1 pound; borax, 4 ounces. Allow the flux to remain on the copper and when the latter is well melted, add the tin, stirring thoroughly. The flux adds iron to the bell metal, which both deoxidizes and gives tone to the metal, producing bells that are very satisfactory from a musical standpoint.

The following alloy makes a good manganese bronze when the metal is twice melted. Copper, 57 per cent; zinc, 40 per cent; tin, 0.5 per cent; iron, 1.00 per cent; manganese, 0.75 per cent; aluminum, 0.75 per cent. Melt the copper, add the iron as tin plate, and the manganese as manganese copper, using 2½ pounds of the alloy containing 30 per cent of manganese. The 1¾ pounds of copper added with the manganese is deducted from the copper in the charge, making it 55¼ pounds of copper, 2½ pounds of manganese copper. The tin is added in the metallic form, and the aluminum should be added before the zinc. When all the ingredients are in the molten mass stir thoroughly and ingot the alloy. Remelt the ingot for castings.

Brass Thought to Contaminate Iron

We have been melting brass in a noncrucible furnace, and then melting gray iron in the same furnace. Some of the iron castings have been so hard that it was impossible to machine them. In places where the metal was thin, it seemed to be chilled. Does mixing the brass and iron have this effect on the iron?

Whether the brass would harden the iron would depend upon its composition. The term *brass* is a very elastic one. If the alloy is one of copper and tin it would harden the iron because tin is soluble in cast iron and renders it very brittle. Copper is not soluble in cast iron and if the two metals are melted together and are cast into an ingot, the copper will separate and fall to the bottom. Yellow brass contains nothing that would harden cast iron, therefore, if the alloy being used is one of copper and zinc, some other reason for the hardness of the cast iron must be looked for.

When making thin castings of iron by melting in brass furnaces, it will be found advisable to add silicon in the form of ferrosilicon, otherwise, the castings are likely to be glass hard. It would be advisable to have an analysis of the iron made to determine if the hardness was not caused by the use of an iron unsuitable for the purpose in view.

Sweating of Lead from Castings Prevented

We have experienced considerable difficulty from sweating of the lead in the castings we make. We do not use highly leaded alloys, simply the regular alloys with copper, 80 per cent; tin, 10 per cent, and lead 10 per cent. The lead only sweats out of the smaller castings, while the large ones seem to hold the lead. Another mixture that causes more trouble than the foregoing consists of, copper, 82 per cent; tin, 9.5 per cent; lead 8.5 per cent, and from 0.25 to 0.5 per cent phosphorus. We cast this alloy into rods about ¾-inch diameter and 3 feet long, and most of the surface shows a lead sweat. We understand that sulphur is used to obviate this difficulty, but we do not know in just what form it is used, or how it is used. Any suggestions you may offer will be thankfully received.

It is not customary to use any flux or secret process to retain lead in castings made from the alloys mentioned. Leaded alloys containing up to 1 per cent phosphorus are made continually without a trace of lead sweat, and nothing is done to prevent lead sweat as such a condition would cause surprise if it occurred. This information does not assist in controlling the lead sweat in the present case, but it shows that the same must be due to abnormal foundry practice. It may be in the melting of the metal, the temperature at which it is poured, or to some more obscure cause. It is very evident something is wrong somewhere, otherwise this difficulty would not be experienced, and although experts may have passed on the foundry practice and have declared it good, there is some point on which they have slipped, and which is responsible.

In all such cases of difficulty in making castings, it is advisable to spare no effort to discover the cause, because once this is known, that particular difficulty can never occur again. If it does crop up, no time is wasted in applying preventive measures. In spite of the fact, therefore, that the foundry practice may be considered normal, it would be advisable to check over every stage of the operations from weighing the metal, to cleaning the finished castings, taking nothing for granted. If the alloys contained over 30 per cent lead, this lead sweat could be expected, and if it only showed slightly on the surface of the castings, it would do no harm, as this is an ordinary condition with such metal. The use of sulphur would be harmful in the case of the alloys mentioned, as it would cause porosity, due to a reaction that would be set up in the metal between the contained oxygen and the sulphur. This reaction would form sulphur dioxide. In highly leaded alloys sulphur dioxide is given off from the liquid metal when sulphur has been used. It would appear that the gas aeriates the copper which contains a small amount of lead, and has a high melting point. This copper solidifies, but the lead is liquid and displaces the gas and is held in the spaces in the copper, like water in a sponge. In the case of the alloys mentioned, there is a shortage of lead, therefore, spongy castings would be produced by the addition of sulphur. Roll sulphur is generally used to retain lead, and there are a large number of methods in vogue for holding in the lead. In the present case it would be best to use a flux of plaster of Paris mixed with 10 per cent borax. Use about 2 per cent of this flux, added half with the copper and half with the lead part of the mixture.

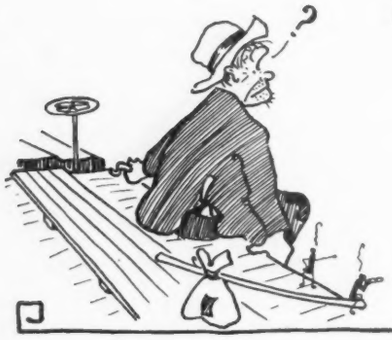
Methods for Tumbling Brass Castings

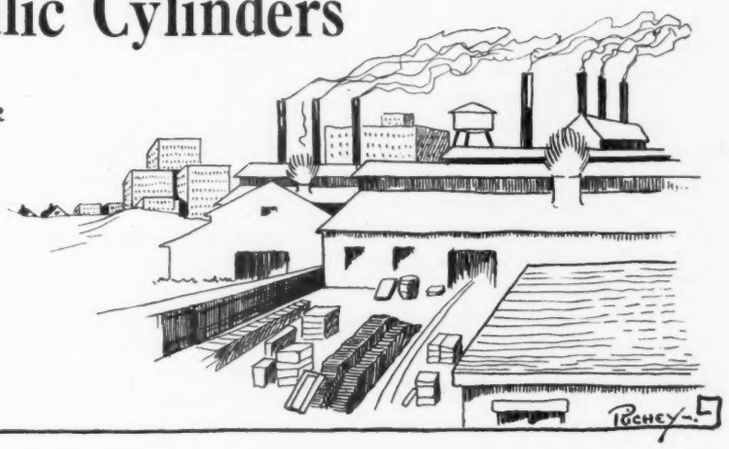
We are making furniture and trunk hardware using yellow brass of the following formula: Copper, 65 per cent; zinc, 35 per cent, and about ½ pound of aluminum additional. We are cleaning them by tumbling with gravel for the purpose of removing the sharp edges and avoiding the use of files for this purpose. We would like to know if there is a better way of rounding the edges than by the use of the tumbling barrel.

It is doubtful if the tumbling barrel method of rounding the edges of these castings can be improved upon as far as economy is concerned. The barrel should be wood lined. It ought to run in water and it must be packed until almost full. It should be run for a period of hours. Instead of gravel for packing, skimmings from the hearth are to be preferred, as they will not scratch like gravel, and the small pieces of shot brass in the skimmings burnish the castings. The brass is recovered from the skimmings being removed from the tumbler when too much has accumulated. This tumbling ought to result in castings having rounded edges and polished surfaces, especially in the case of an alloy such as the one used. If dry tumbling with gravel is being carried on, the results will not be satisfactory, and a change should be made to wet tumbling.

Bill Talks on Hydraulic Cylinders

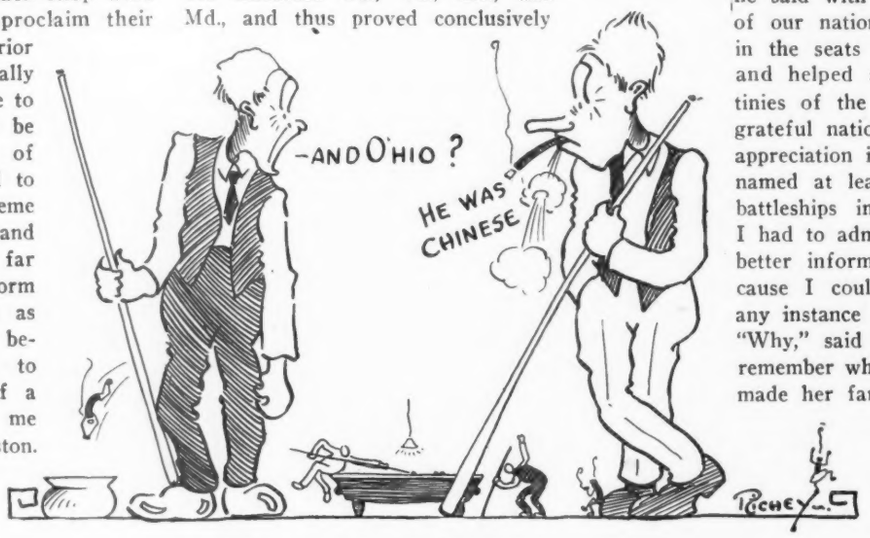
BY PAT DWYER





DURING the course of my perambulations around these more or less closely United States I have had occasion to notice many things other than the number of stacks in a town. 'Tis true that I could estimate fairly accurately by the visible number of stacks, the possible or probable number of available jobs in the town which would fit in with my capabilities, but that was only an incident and easily disposed of by making a tour of the shops and picking one out whose general features and color scheme appealed to my aesthetic sense. I will be frank to admit that the scale of remuneration, the character of the work and the personality of the man I was to work for, had a direct bearing on deciding the question. These factors were given precedence in the order described.

One of the features I noticed in particular was that no two foundries did things in exactly the same way. The general features were alike, but there was always some distinctive point in which the methods of one shop differed from another. I also found that the men in each shop were willing to uphold and proclaim their practice to be the superior of others, either individually or collectively. In justice to the foundrymen it must be admitted that this trait of character is not confined to them alone. As an extreme instance of this kind and as an illustration of how far a man will go in that form of indoor sport known as "Kidding yourself into believing what you want to believe," I'll tell you of a man who worked with me in a shop in East Boston. He was not a native of that interesting, if somewhat crooked town—crooked, of course, is used in a topographical and not in the generally accepted sense. He had drifted there from some southern town close to the Mason and Dixon line. The story of Plymouth Rock, which has done so much in molding, shaping and directing the trend of thought in New England, meant nothing in his young life. He maintained that while the discovery of America was rightly credited to Columbus the spelling of the name was entirely erroneous and the popular tradition that the gentleman came from southern Europe was preposterous. He said that the most superficial knowledge of the history of Virginia and the names and titles of her distinguished sons would disclose the fact that Col. U. M. Bus was a native American and that the claims of the F. F. V.'s really go further back than is generally supposed. He also ridiculed the idea that U. S. was an abbreviation of United States or even Uncle Sam. He claimed that it was adopted in the same way that the popular abbreviations of some of the individual states were adopted, that is by using the first and last letter of the name. He instanced Pa., Va., Me., and Md., and thus proved conclusively at least to his own satisfaction that U and S were simply the first and last letters in the name of the distinguished colonel already mentioned—U. M. Bus. I often thought over that theory and one day I put the proposition up to Bill and asked him what he thought of it.



BILL HOLDS THAT "ALL IS NOT GOLD THAT'S YELLOW"

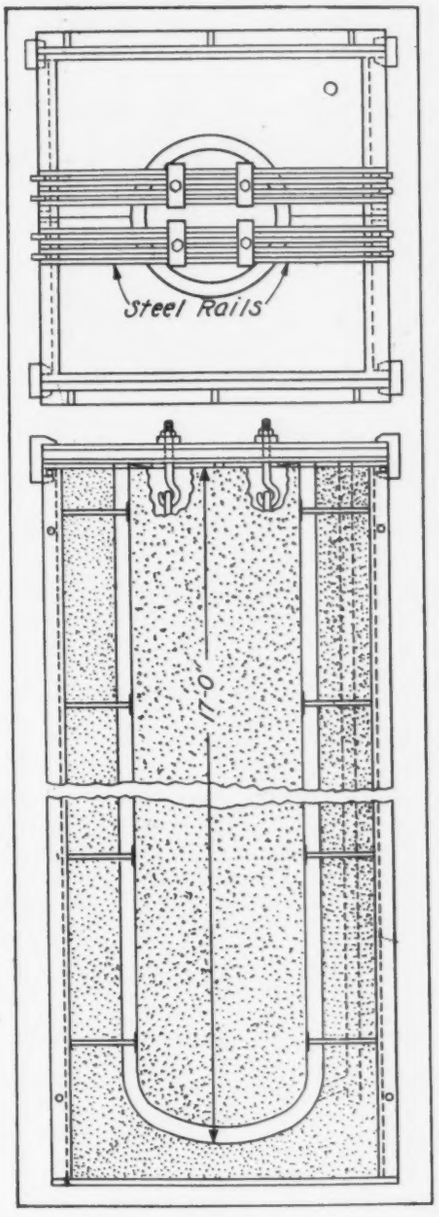
"All buncombe," said he. "And anyway what difference does it make now, who discovered the country first? They are all dead and I bet some of them have discovered queerer countries than America by this time. Millions of people have discovered this country since the brave old days when the trade winds first whistled through the rigging of the NINA, the PINTA and the SANTA MARIA. They have discovered it to be a land flowing with milk and honey, and inundated, until a recent cruel amendment to the constitution went into force, with beer in bulk, draught and can. They have discovered it to be a land where every man is measured by his worth and individual effort and where no distinction is made because of creed, caste, nationality or former state of servitude.

"You and I have no kick coming," he said with a grin. "Men of our nationality have sat in the seats of the mighty and helped shape the destinies of the republic. The grateful nation, to show its appreciation in the past, has named at least two of her battleships in their honor." I had to admit that he was better informed than I, because I could not recollect any instance of that nature. "Why," said he, "don't you remember when the O'REGON made her famous trip from the Golden Gate, around Cape Horn to New York and you surely haven't

forgotten that Admiral Dewey's flagship was known as the O'LYMPIA?"

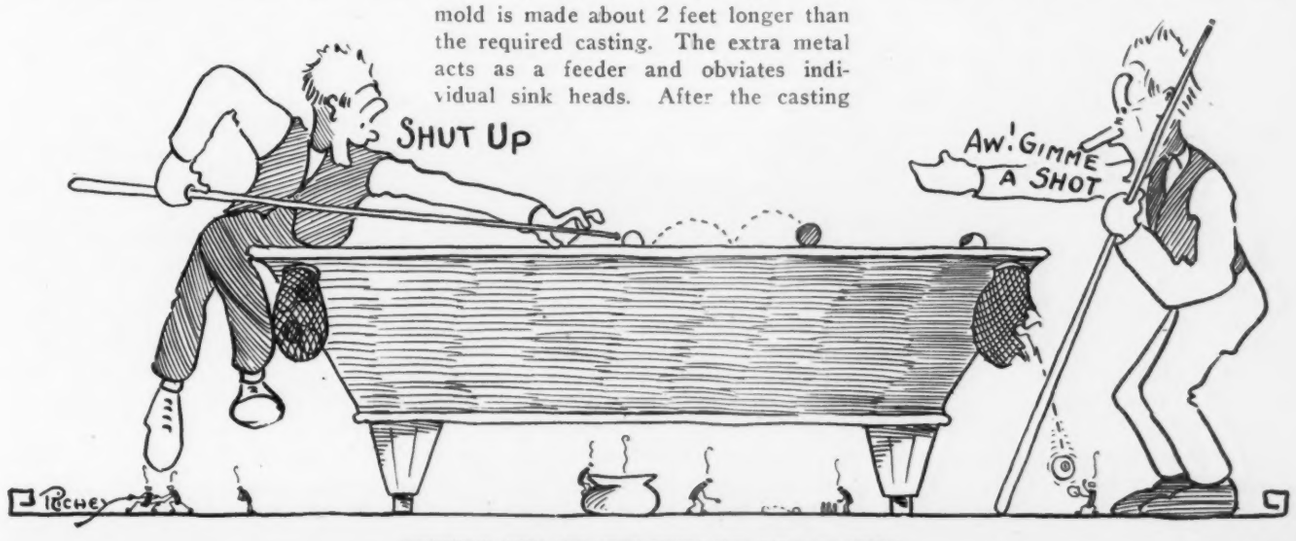
"And now talking of those things reminds me of the year of the Spanish war. I was working in a shop in the middle west at that time which was devoted to the manufacture of heavy machinery. I only stayed there a few months but I had occasion to visit the same place lately and I found that they still made practically the same line of castings but had also taken on the manufacture of hydraulic cylinders and rams for automobile-tire factories. These castings are closed at one end and vary from 20 to 30 inches inside diameter with an average metal thickness of 4 inches. They are molded horizontally and then up-ended and poured vertically

"Heavy cast steel flasks with planed joints are employed for molding these castings. The cope is not rammed on top of the drag as in ordinary practice, but each half of the mold is made individually. The flask is provided with four pin holes in the flanges of each half. That is, there are two pin holes in the flange of each side on the cope and drag. Loose pins dropped in to these holes serve to locate the two halves of the mold in their proper relative position when the flask is assembled for pouring. The end pieces of the flasks are bolted to the sides. The ends which are down when the casting is poured are plain flat plates, but the ends which are up, are provided with an opening corresponding to the size of the casting which is to be made. An additional hole also is provided near one corner of one of the end plates, through which the metal enters a long down runner. This in turn is connected to a short gate entering near the bottom of the mold. In this way the steel enters the bottom of the mold first and gradually rises until the mold is filled. The mold is made about 2 feet longer than the required casting. The extra metal acts as a feeder and obviates individual sink heads. After the casting has been cleaned it is placed in a lathe and this extra length cut off.



THE CORE WAS SUSPENDED FROM STEEL RAILS RESTING ON THE TOP OF THE FLASK—TWO BOLTS WERE ATTACHED TO EACH HALF CORE

"When preparing to make a mold for one of these hydraulic cylinders in the foundry, a bottom plate is laid on the floor in an approximately level position. One half of the flask is set on the plate, joint side up, and the pattern is bedded-in instead of being rolled over. It could be rolled over, but the bedding-in method takes less time and relieves the crane of several lifts which would have to be made if the flasks were rolled over. One ramming of sand is placed in the flask and rammed firmly and then the long piece of pipe which is to serve as a gate pin is set, covered with facing sand and tucked firmly into position. A sufficient quantity of sand is then rammed in the flask to bring it within a couple of inches of the bottom surface of the pattern which is then lowered into the flask. A number of battens attached to the joint side of the pattern extend on each side and rest on the joint of the flask. These battens in addition to supporting the weight of the pattern, also serve to locate it definitely in the flask. A long line or straight edge is employed to locate it in the center, that is longitudinally. The center marks on the flask ends of cope and drag coincide and thus by lining the patterns up by the same marks the two halves of the mold are bound to line up properly when assembled. Facing sand is banked around the pattern and the remainder of the flask filled with sand and rammed. The superfluous sand is scraped off and a parting made, after which the pattern is withdrawn, the mold finished, whitewashed and placed in the oven. The other half of the mold is made in a similar manner with the exception that no provision is made for either gate or runner.



OBVIOUSLY ODDS ARE EVEN WHEN THE GAME IS KELLY

"The core for one of these castings is made in halves from a half core box. Each half core is provided with a number of long iron rods for stiffeners. Two of these rods terminate in loops at the end which is to be uppermost and are used for supporting the weight of the core after the mold has been up-ended for pouring. After the core box has been rammed full of sand and before the plate is put on, a long channel or gutter is dug along the middle of it and then filled again with black sand from the floor. A number of holes for bolts also are provided, the purpose of which will be seen when reference is made to assmbling the core.

"The two half cores now have been made, rolled upon two plates, placed in the oven, dried and taken out again. The next step is to roll them over on their backs and remove the black sand from the opening down the center. One half is then taken and placed on a couple of horses and the other half superimposed on it. The entire core is calipered for size at various points and rubbed to a bearing. The top half is then taken off and held by the crane while a quantity of paste is spread on the joint of the lower half. The upper part is then returned and both halves bolted firmly together by a number of bolts which pass through the holes in each half previously mentioned. The outside of the joint is daubed with slurry and the countersunk holes which carry the bolt heads on one side and the nuts on the other are filled with sand and slicked, after which the entire core is returned to the oven until the patches are dry.

Assembling the Mold

"One half of the mold is laid on the floor, it does not matter if it is not perfectly level, but it will facilitate closing of the mold if it is approximately so. The core is lowered into the mold horizontally until it rests on four long stemmed chaplets, equally spaced, which had been driven through the sand while it was green until they came in contact with the bottom plate. Two chaplets on each side with their outer extremities touching the walls of the flask prevent the core from shifting sideways, and two chaplets in the other half of the flask prevent it from moving in that direction. After the core has been located definitely and any necessary adjustments made to the chaplets to insure an even distribution of metal, the cope is lowered into place. The joint is then bolted and clamped together. Two eye bolts are attached to the loops in the ends of the core rods and secured to two short pieces of rails or strong bars which span the opening in the end of the flask. The nuts on these bolts are tightened until there is a fair strain on the bolts and it is certain that there will be no sag when the mold is up-ended and all the weight of the core is hanging on them. When everything is secure the crane is hooked on and the entire mold turned up on end where it is made ready for pouring by setting on a runner head and slipping some blocking and wedges between the top of the core and the rails from which the core is suspended. The extremities of the rails are clamped to the flange around the top end of the flask and the rails thus answer the double purpose of holding the core up and of also holding it down when the pressure of the molten steel comes against it.

Casting is a Tumbling Barrel

"You know what a difficult proposition it is to clean the sand out of a casting of this description. At this place I am telling you about it is a cinch. After the casting has cooled sufficiently, it is dumped out of the flask. The long rods and as much of the core sand as possible is removed. The casting is then taken out into the yard where it is turned up on end and filled with pig iron. No, not molten pig iron, but short pieces of hard, rough sand cast pipe. In fact the harder and rougher they are the better they like 'em. A spider is fastened in the open end with a number of set screws after which it is lowered back to a horizontal position and placed in an improvised lathe consisting of a driving head and a tail stock. It is allowed to revolve for a couple of hours by which time it is as clean if not cleaner on the inside than it is on the outside, and most of the sand has been discharged between the wings of the spider in the open end. It is certainly an efficient rig and the funny part of it is that it was designed and installed by a man who was not a foundryman. I am a firm believer in the theory of the shoemaker sticking to his last but there are occasions where an outsider has broken all records on account of looking at a thing from a purely speculative angle and not being fettered by habit, custom or tradition and this little stunt I've told you of where they fill the casting with pieces of pig iron and turn the casting itself into a tumbling barrel, is one of them."

American Clays Prove Their Value

The possibility of using American clays in competition with those which have hitherto been imported was studied by A. V. Bleininger, ceramic chemist, bureau of standards, who has published the results of his findings in a technical paper of the bureau.

The physical properties of three typical German clays formerly imported in large quantities are described in detail and on the basis of constants, which makes possible accurate comparison and evaluation of American materials. Similarly, the physical characteristics of 23 American and two English bond clays are given. Of these, several approach the Klingenberg and Grossalmerode clays quite closely. Others, by suitable blending, can be made to equal or excel the European clays.

The author says that for crucible making the best clays should show a pore-shrinkage water ratio of not more than 1:1; a modulus of rupture for a clay-sand mixture of 1:1 of about 325 pounds per square inch; a vitrification point of 1150 degrees Cent., or lower; no marked evidence of overfiring at 1400 degrees Cent.; and a softening point corresponding to Orton cone 31, or above. The value of graphite for crucible making is expressed by the factors of density, surface factor and ash content. Artificial graphite and coke, it is said, might possibly be used, but are subject to certain limitations.

The results obtained from the tests form the basis for the author's assertion that we have clays in the United States which make possible the manufacture of several kinds of refractories without the use of imported materials. The fact is emphasized that in nearly every case the use of an intimately blended mixture of suitable clays is to be preferred to the use of single clays.

Company Is Incorporated

The Globe Metal Products Corp., Sheboygan, Mich., has been incorporated and has built a modern foundry. It will take over all the foundry business heretofore conducted by the Globe Co., making all castings required by that company as well as doing a general jobbing business. The offices of the two companies will be one.

The Southern Brass Mfg. & Plating Co., Houston, Texas, is contemplating the establishment of a gray iron and semisteel jobbing shop to specialize in oil well supplies. Robert Voigtlander of this company desires information relative to the purchase of pig iron, coke and sand.

Protects Workers in Converter Shop

Large Hoods Carry Off the Burnt Gases—Swinging Platforms Are Provided for the Workmen When Pouring Metal into the Converters —Steel Doors Cover the Slag Pits

BY H. L. CAMPBELL

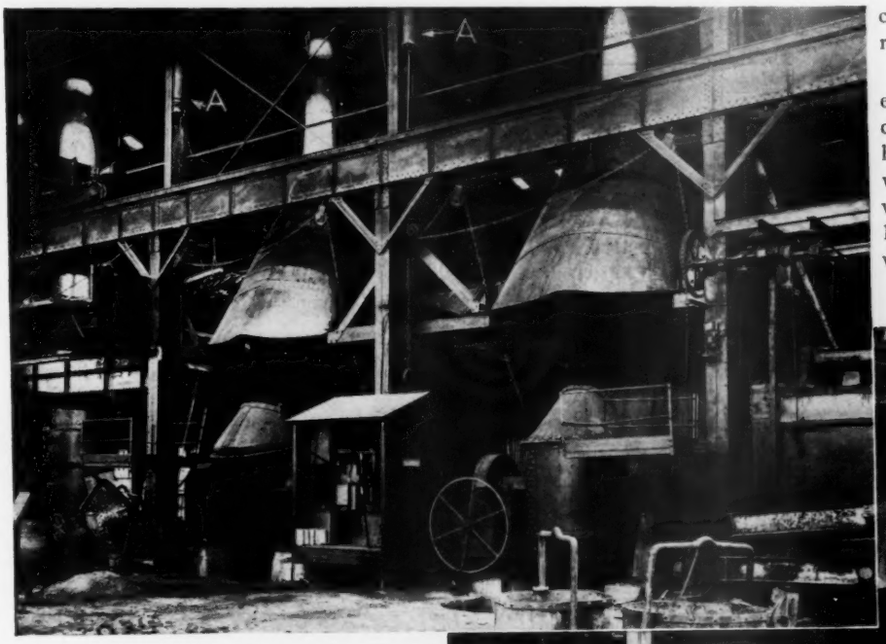
IN STEEL foundries where side-blown converters are used, the equipment around the converters is not always arranged so as to give the greatest ease of operation and maximum safety for the workmen. Such arrangements are particularly desirable because converter practice requires a large amount of personal attention and care of the operators. The lining of the converter must be repeatedly inspected and kept in repair. The tuyeres must be kept open and the slag removed from the mouth of the converter after each blow.

During the converting process a large amount of slag is blown from the bath. This slag collects in the stack or on the wall at the back of the converter and, when it has accumulated in sufficient quantity, will fall to the floor in large sheets. This produces a hazard for workmen walking behind the converter. Preliminary to the blowing of the metal, it is necessary that the operator inspect the tuyeres and tilt the converter to the proper angle. In order to do this he must go behind the converter where he may be in danger from falling slag which has been deposited. Many attempts have been made to remove the slag from the hood after each blow by means of hammers or chains hung in the stacks, but these methods have proved to be unreliable. A swinging apron may be used to advantage as a protecting cover to the area below the hood when the converter is not blowing. Fig. 2 shows two swinging covers back of the converter. These are hinged to the structural members which support the hoods. They are raised by means of air hoists, *A*, Fig. 1, which are located near the roof of the building and are connected to the covers by chains. The covers are constructed of plate and structural steel. These illustrations are from the installation at the steel foundry of the Industrial Works, Bay City, Mich.

With many installations the hoods over the converters are built too small and are inadequate to carry off the gases produced during the blowing of the metal. In these cases the gases will be deflected by the hood and roll out in clouds into the foundry. If the cupola charging platform is open to the main foundry space, the gases from the converters will be a great annoyance to the workmen who charge the cupola. In some foundries no hoods are provided and the natural ventilation in the foundry is relied upon to carry away the waste gases. This practice is wrong and produces a condition which is opposed to the safety of overhead crane operators and, in fact, all foundry workmen.

Hoods of ample size should be provided to carry away all of the products of combustion from the converter. The hoods should be located so that they will receive the gases when the converters are in a blowing position. Fig. 1 shows two hoods over 2½-ton converters. The area at the mouth of

(*Concluded on page 376*)



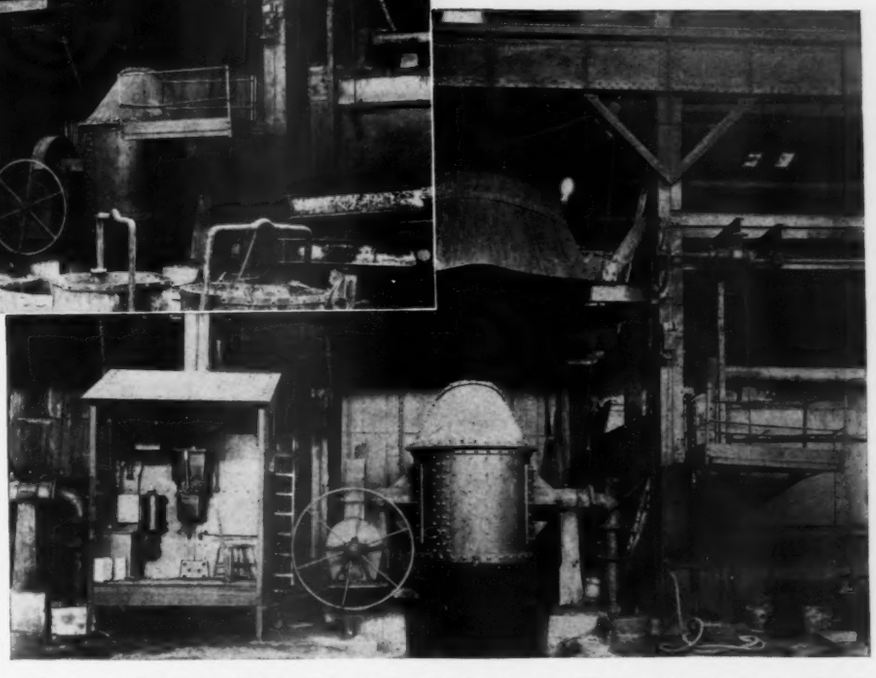


FIG. 1—AT THE LEFT—LEVERS FOR OPERATING THE CONVERTERS ARE CONVENIENTLY LOCATED IN A BOOTH ENCLOSED ON THREE SIDES—NOTE THE SWINGING PLATFORMS FIG. 2—THE STEEL DOORS BEHIND THE CONVERTER WHEN RAISED, CATCH ANY SLAG WHICH FALLS FROM THE HOOD

The author, H. L. Campbell, is metallurgist, the Industrial Works, Bay City, Mich.

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Harmonize the Organization

CORRECT organization is essential to the best results in any concern, especially if it is a large one. In organizing a foundry, four distinct divisions must be considered. These are patternmaking, molding and casting, accounting and metallurgy. The executive in charge over all these four departments usually is one who has served his time as a molder and is thoroughly acquainted with that branch of the art. Accounting is too far afield to cause him concern, and so the chief accountant usually directs his departments as he chooses. However, the executive sometimes feels entirely familiar with the other two branches, namely patternmaking and metallurgy, and often he considers himself as much an authority on these specialties as he is on molding. This together with the fact that the work of these branches is so interlocked with that of molding induces many arguments between the heads of each of these departments. Sometimes the metallurgical work is divided between the chemist who furnishes the analyses and the superintendent or one of the foremen who calculates the charges for the cupola. In such cases the dispute can only be caused by difference on the correctness of the analyses furnished by the chemist. In this position the chemist has little responsibility and the use of initiative on his part is not encouraged. Small benefit will be derived by the company from the chemist's services under such conditions.

Where the chemist has charge of calculating the mixture, he still has the loop hole that the iron was not properly charged, but when he is given entire charge of the cupolas as well as of the laboratory, he has no alibi. He must produce the correct iron. However, he also must be able to demonstrate that the fault is due to molding and not to the iron when defective castings are found. This is not always an easy task when his superior is a molder and wishes to place the blame on the metallurgist. The solution of the problem then will hinge on finding men who will pull together to find the cause of the difficulty and will place the blame where it belongs.

The patternmaker has just as many and as serious disagreements with the foundry superintendent as does the metallurgist. Fortunately, as broader minded men are secured for these positions the disagreements are fewer. However, there often is ground for serious argument as to the correct way to make a pattern and occasionally it is hard for both the patternmaker and the molder to see the problem from the same angle. In such cases if the pattern department is under a separate head there frequently is trouble. A solution for this difficulty is afforded by one company which has made the superintendent of the pattern shop an assistant superintendent of the foundry. In this case the man who directs the making of the pattern also is responsible for putting it in the sand. Then the foundry secures the pattern just as they want it to be, and if it does not function properly there is no long drawn-out argument as to which department to charge with the scrap. This plan has another advantage in that it familiarizes the head patternmaker with the problems of the foundry. With this knowledge of molding conditions his value as a patternmaker is increased and often he can see a mistake and have it corrected before the pattern is sent to the foundry. This saves the expense involved in returning the pattern to the pattern shop after a trial casting had proved it incorrect.

Trade Outlook in the Foundry Industry

ALTHOUGH the switchmen's strike has been sporadic and has varied in intensity at the different large centers throughout the north, its effect has been unusually severe upon the entire foundry industry. During the past 10 months, heavy drafts have been made upon stock piles and most foundries have been reduced to a bare minimum in supplies of both coke and pig iron. For this reason the railroad strike found many with only a few weeks' supply of raw material upon which to operate.

Iron Restricted

With the commencement of the strike blast furnaces throughout Ohio, Indiana, Illinois and Pennsylvania were blown out in quick succession until on April 22 it was estimated that the total iron production of the country had been reduced by 500,000 tons. At this time shipments of coke and coal were being resumed and the indications pointed to an early relief in furnace operation, although iron was being stacked and little was filtering through to relieve the foundry distress. The strike gripped the main industrial centers and gateways through which much of the iron must pass to reach the great central western foundry districts. Pittsburgh, Cleveland, Cincinnati, Columbus, Buffalo and St. Louis up to the week of April 19 constituted barriers between the furnaces and their customers, and effectively prevented the transportation of iron from either the northern or southern furnaces. In the South, shipments remained free, and furnaces throughout that section concentrated upon filling orders in the districts where deliveries were unobstructed. The same conditions obtained around Chicago, where freight could move freely to the north and west. Consequently when transportation conditions become easier, it will be possible to give preference to those districts which have been cut off for the past two weeks. Southern Ohio and Indiana manufacturers have been singularly fortunate in having from two to four weeks' supply of iron on hand. In this respect they have been more favored than those in the automobile manufacturing centers, where it has been necessary in many instances to borrow iron and move it by automobile truck to maintain day-to-day operation.

Prices of Raw Materials for Foundry Use

CORRECTED TO APRIL 23

Iron		Scrap	
No. 2 Foundry, Valley	$43.25 to 45.25	Heavy melting steel, Valley	$25.25 to 25.50
No. 2 Southern, Birmingham	40.00 to 42.00	Heavy melting steel, Pittsburgh	25.00 to 26.00
No. 2 Foundry, Chicago	43.00 to 45.00	Heavy melting steel, Chicago	23.50 to 24.00
No. 2 Foundry, Philadelphia	45.60 to 46.10	Stove plate, Chicago	34.00 to 34.50
Basic, Valley	43.50 to 44.00	No. 1 cast, Chicago	42.25 to 42.75
Malleable, Chicago	43.50	No. 1 cast, Philadelphia	38.00 to 40.00
Malleable, Buffalo	46.25	No. 1 cast, Birmingham	30.00 to 31.00
Coke		Car wheels, iron, Pittsburgh	39.00 to 40.00
Connellsville foundry coke	11.00 to 13.00	Car wheels, iron, Chicago	38.50 to 39.00
Wise county foundry coke	12.00 to 12.50	Railroad malleable, Chicago	30.00 to 30.50
		Agricultural malleable, Chicago	30.00 to 30.50

Coke Need Acute

While the iron situation has been serious, the shortage of coke has been more acute and has crippled production of gray iron castings throughout New England and the central west north of the Ohio river. For one week, the Connellsville district did not ship any coke outside of the immediate district. The lack of empty cars strangled production, so that in the week ending April 17, the output dropped to 48.6 per cent of the total shown for the previous week. It is anticipated that the evil effects will continue even with the resumption of normal transportation. With the great number of cars, loaded and enroute, which never have reached their destinations, reviving freight movements will create a vacuum for a time when few empty cars will be available at the ovens. Practically no coke is or has been shipped from the south, as most of that produced is used within the immediate vicinity of the ovens or is shipped into the southwest. St. Louis, Cincinnati, Chicago, Detroit and Cleveland, all were hard hit. Some foundries suspended, while others with some coke in the yards reduced operations to 30 to 50 per cent of normal husbanding their fuel supplies. Those which were fortunate enough to possess raw materials found difficulty in shipping. Some foundries making automobile cylinders filled every available bit of storage space, even while shipping as many castings as possible by truck. With the uncertainty as to deliveries, little change has been noted in coke prices. In the East, prices range from 10 to $12 for last half delivery with an inclination toward the higher figure for immediate or for first half shipment. By-product ovens remote from coal supplies have been snuffed out. In Indianapolis, the gas company which supplies foundry coke to much of the surrounding territory was forced to operate at about 20 per cent of normal for a time, and finally was obliged to draw upon an emergency supply of coke in its own yard to make water gas for its consumers' needs.

Prices Advance

Rising costs and excessive demand for castings have resulted in a general advance in practically all lines. This condition has been more marked in malleable and gray iron. Some malleable shops which adjust their contracts quarterly advanced prices by about 10 per cent on April 1. Costs seldem are considered by customers seeking gray iron castings, particularly in automobile and allied lines. Railway buying has not yet made an appreciable impression upon the steel foundry inactivity, and but little inquiry has developed among malleable plants.

Brass foundries continue active, and have not been as hard hit by the strike as have the ferrous interests, although shipments to consumers and from producers have been affected. The demand for all classes for plumbing goods is heavy, while specialties are eagerly sought by manufacturers. Prices on nonferrous metals based on New York quotations follow: Copper, 18.50c to 18.62½c; lead, 8.75½c; tin, 62c; antimony, 10.25c; aluminum, No. 12 alloy, producers price, 31.50c and open market, 31c. Zinc is quoted at 7.87½c, St. Louis.

Comings and Goings of Foundrymen

WALTER E. BROADBELT recently has become affiliated with the Michigan Steel Casting Co., Detroit, where he is engaged in an advisory capacity in charge of special rigging and equipment to improve foundry practice. Mr. Broadbelt served his time as a patternmaker in foundries in Philadelphia. Later he was employed by the Crucible Steel Casting Co., Landsdowne, Pa., and the Lebanon Steel Foundry Co., Lebanon, Pa. He resigned from the latter company last February after five years in charge of the planning and inspection departments.

Herman Dehn has been made foundry superintendent of the newly organized North Milwaukee Foundry Co., Milwaukee.

George A. Gumphert, Jr. addressed a recent meeting of the Philadelphia Foundrymen's association on the subject, "Wood and Metal Patternmaking."

W. R. Forrester has resigned as metallurgist for the Treadwell Engineering Co., Easton, Pa. to accept a similar position with the Milton Mfg. Co., Milton, Pa.

C. S. Lovell, Walker & Pratt Co., Watertown, Mass., was unanimously elected vice president of the New England Foundrymen's association at the regular April meeting of that society.

David Hurst has been appointed foundry foreman for the Mathew Moody & Sons Co., Terrebonne, Que., Canada, succeeding B. A. Montressor, who died recently.

A. J. Kuzniewski, until recently assistant foundry foreman of the Geo. H. Smith Steel Casting Co., Milwaukee, has accepted a position as general foundry foreman with the Erie Forge Co., Erie, Pa.

Ralph E. Carpenter has resigned his position as manager of the laboratories of Aluminum Manufactures, Inc., Cleveland, and has become associated with the Hollister-White Co., Inc., Boston.

W. R. Balch of the *Boston Transcript* was the principal speaker at the April meeting of the New England Foundrymen's association, held at the Exchange club in Boston, Wednesday, April 14.

Charles H. Norton, chief engineer of the grinding machine division of the Norton Co., Worcester, Mass., lectured on "Grinding Heat-Treated Steel" before the Steel Treating Research society of Hartford, Conn., Friday evening, April 23.

A. C. Johnston, formerly chief engineer of the Chicago works, the Link-Belt Co. has been elected vice president and resident general manager of the Chicago plant. He succeeds Prentiss L. Coonley, who resigned to become president of the Isko Mfg. Co.

J. W. Powelson, formerly works manager of the Pittsburgh Model Engine Co., Pittsburgh, has been made president and general manager of the newly organized Powelson Foundry & Machine Co., Inc., Rochester. F. C. Kimmel is vice president and treasurer of the company.

R. C. Gosrow has established an office as metallurgical engineer and electrometallurgist in the Spreckels building, San Francisco. Mr. Gosrow will specialize on the metallurgy of iron, steel and ferroalloys, and will engage in consulting work on the design, construction and operation of electric furnaces.

A. P. Slater has resigned his position as foundry superintendent for the Willys-Overland Co., Detroit, to become assistant general superintendent for the General Aluminum & Brass Mfg. Co., which recently has taken over the plant of the McAdamite Aluminum Co. of that city. For the present Mr. Slater will be located at the McAdamite foundry.

W. N. Best, president of W. N. Best, Inc., New York, was the speaker at the regular monthly meeting of the Pittsburgh Foundrymen's association at the Chatham hotel, Pittsburgh, on the evening of April 19. Mr. Best's talk, which was illustrated by lantern slides, was on the subject of oil burners and aroused considerable discussion, especially in the matter of the cost and application of oil as the heat agent in comparison with natural gas.

Addresses the Detroit Foundrymen

D. C. Stanbrough, superintendent of the Packard Motor Car Co., addressed the Detroit Foundrymen's association on April 15, taking for his subject the development of executive ability. He stated that decision, initiative, ability to plan and concentration are the four fundamental characteristics of a good executive. These qualities generally must be developed in the man who is selected and clothed with authority. An executive may be weak in the possession of some of these qualities but he must have all of them in some degree to start with and it is the business of those in authority to train him fully to acquire the characteristics in which he may be lacking.

Promoting a man and clothing him with a certain amount of authority is not enough. He must be taught, or made to realize just what authority means. In the speaker's opinion the best definition is: "The authority to issue an order carries with it the responsibility to see that it is carried out." He emphasized that point because in the last analysis the ability of every executive is measured by the amount of responsibility he assumes in seeing that his orders are carried out. In conclusion, the speaker touched on the factor of personal appearance. The habits, appearance and dress of the executive have a powerful influence on the men under his charge.

Elect Officers To Head Handling Association

Charles F. Lang, president of the Lakewood Engineering Co., Cleveland, was elected president of the Material Handling Machinery Manufacturers' association, at a recent meeting of the board of directors. Other officers chosen were: Vice president, Rumsey W. Scott, Otis Elevator Co., New York; treasurer, Lucian C. Brown, general sales manager, Elwell Parker Elevator Co., New York; and secretary and manager, Zenas W. Carter. These members and Fred Stadelman, eastern manager of the Wellman-Seaver-Morgan Co., Cleveland, and W. F. Merrill, president of the Lamson Co., Boston, will constitute the executive committee of the association.

An honorary membership was voted to Calvin Tomkins, retiring president, in appreciation of his work in behalf of the association in the past year, and to Edward F. Carry, president of the Haskell & Barker Mfg. Co., Michigan City, Ind., in recognition of services in initiating the organization of the association at the close of the war.

The board of governors will include

the members of executive committee, and F. W. Hall, manager of the Sprague Electric Works, New York; H. W. Standart, secretary and treasurer of the Northern Engineering Works; J. C. Walter, Alvey-Ferguson Co., Cincinnati; D. V. Jenkins, Watson Elevator Co., New York; Roy C. Owen, vice president Lakewood Engineering Co., Cleveland; Thomas Robins, Robins Conveying Belt Co., New York; G. O. Helmsteadeter, sales manager, Hyatt Roller Bearing Co., New York; and C. W. Moore, secretary and treasurer, Jeffrey Mfg. Co., Columbus, O.

Establishes Nonferrous Metals Section

At the annual meeting of the American Foundrymen's association to be held in Columbus, O., Oct. 4 to 8, inclusive, a new department will be added to the program to be known as the nonferrous casting section. At the meetings of this section, papers and discussions of interest to the practical brass and aluminum foundrymen will be presented. It is understood that the Institute of Metals division of the American Institute of Mining and Metallurgical Engineers will hold a convention in Columbus during the same week, and it is proposed to have joint sessions of this body with the newly established nonferrous section.

C. S. Koch, president of the American Foundrymen's association, has appointed Lucien W. Mueller, of the H. Mueller Mfg. Co., Decatur, Ill., and Robert S. Archer, of the Aluminum Manufactures, Inc., Cleveland, as members of the papers committee to represent this new section.

Will Erect Foundry

The Minerva Engine Co., Cleveland, has broken ground for a new gray-iron foundry. The first unit will have approximately 15,000 square feet of floor space and will provide an initial capacity of 20 tons daily. Machine shops and assembly departments are to be erected shortly. Allen & Osborn, 700 Rose building, Cleveland, have been appointed to supervise all construction and building operations. The officers are: President and treasurer, C. S. Colby; vice president, R. K. Johnson; secretary, L. R. Long; and financial director, Julius Stern.

Bruce E. Fraser, formerly of the Courtney-Fraser Co., Inc., Akron, O., has opened an analytical laboratory, located at 531 Main street, Buffalo, to be known as Fraser Laboratories, Inc.

Herman F. Giele, Malleable Veteran Is Dead

Herman F. Giele, for the past 10 years foundry superintendent of the Grabler Mfg. Co., Cleveland, O., died after a brief illness at Johns Hopkins hospital, Baltimore, Md., on Saturday, April 17, 1920, at the age of 67.

The history of his life is of particular interest to foundrymen, especially to those engaged in the malleable iron industry. It is given to few men to devote, as he did, 51 years to the study and development of processes leading up to the present high standard attained by manufacturers of malleable iron castings.

In reviewing today the early work of Herman Giele and his contemporaries in the malleable iron field, it is only fair to recall that they were not only engaged in developing a new and at that time unknown material, American black-heart malleable, as distinguished from the European white-heart malleable iron, but developing also methods for its production on a commercial basis. Doing it without the aid of chemical analysis, pyrometers, microscopes or any of the wealth of information, precedent and experiences now available. They were not governed by technical standards but by ideals.

HERMAN F. GIELE

Mr. Giele began his life work in a foundry in 1869 at the age of 16. He spent several years in various foundries in central and southern Ohio during which time he met his life long friend B. J. Walker. The two men went to Erie, Pa., in the spring of 1875. They worked first for the Jarecki Mfg. Co., but after a short time they went to the Erie Malleable Iron Co. At this plant they collaborated in conducting a long series of experiments extending over a period of 18 years on iron mixtures, melting and annealing and on problems connected with furnace construction.

Their early furnaces, both for annealing and melting were quite small, principally because at that time there was no mechanical handling equipment available. These early furnaces were provided with flat level roofs and depended for their operation entirely on natural draft. There was no means for controlling the mixture except from information gained from an examination of a fractured test bar. The volume and pressure of draft in the furnaces depended altogether on atmospheric conditions. Furnaces usually were charged between midnight and four in the morning and were tapped at any time between afternoon and the following midnight.

In 1893 Mr. Giele was engaged as superintendent by the Gould Coupler Co., which projected what was at that time the largest malleable iron foundry in the country. He personally supervised the building of the furnaces besides purchasing and installing the necessary equipment. He afterward built up an operating organization. At this plant he introduced the camel back melting furnace and mechanical draft melting and annealing furnaces.

In 1900 Mr. Giele organized the Meadville Malleable Iron Co., Erie, Pa., and as vice president and general manager, constructed and operated the plant. He returned to Erie, Pa., in 1906, to assume charge of the erection and operation of the malleable iron plant of the Morse Iron Works, but retained a directorship in the Meadville Malleable Iron Co. He returned to Meadville for a year in 1909 and for the past 10 years he was foundry superintendent at the plant of the Grabler Mfg. Co., Cleveland, O. During the war he developed at this plant a successful method of producing the difficult castings for the Mills hand grenade.

During his long career as foundry manager and superintendent, he not only instructed hundreds of subordinates in the practice of making malleable ifon castings, but also gave advice and help freely to all foundrymen.

Mr. Giele was married to Amelia Kunz in 1881. She died in August, 1919. He is survived by a son, Walter Giele, of Lebanon, Pa., and two daughters, who reside in Cleveland.

Protects Workers in Converter Shop

(*Concluded from page 371.*)

each hood is 108 square feet and the diameter of the stacks leading through the roof is 3 feet.

In many foundries producing converter steel castings, a rudely constructed wooden ladder or stand is provided for the workman who guides the ladle of molten metal from the cupola as it is poured into the mouth of the converter. Due to the rough handling which the ladder receives when it is pulled around from one place to another, it soon becomes dilapidated and unsafe. With the pit open in front of the converter, as is necessary when the converter is in use, it is dangerous to use an unstable ladder near the front of the converter.

A platform attached to a column at the side of the converter will serve as a safe means of raising the level of the workman to the position where he can easily control the pouring of the molten metal into the converter. The platforms shown at the side of each converter in both illustrations have hinged connections at the columns and

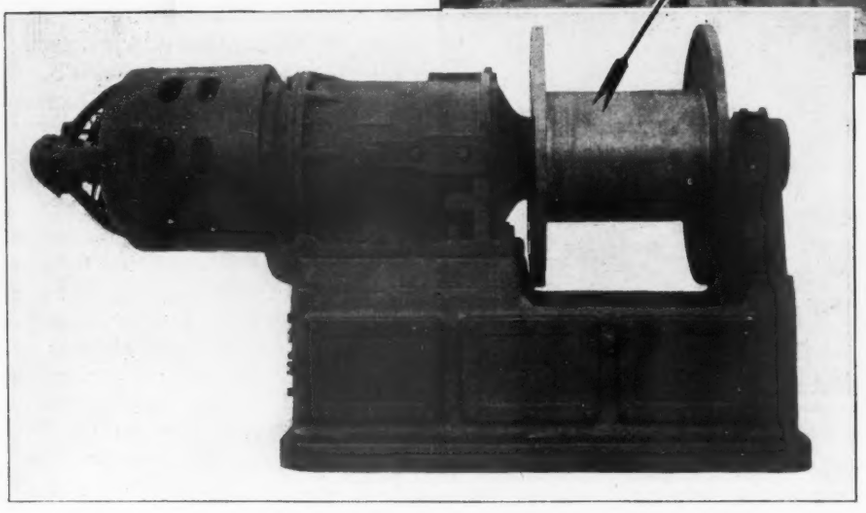


FIG. 1—ALL MOVING PARTS OF ELECTRIC CAR HAULING WINCH ARE ENCLOSED

are constructed of structural steel and steel plate. The floor of each platform is 5 x 5 feet and is raised 7 feet from the ground level. When the platforms are not in use they may be swung to one side as shown in Fig. 2, so they will not interfere with subsequent operations.

A pit is provided under each converter to allow the ladles to be lowered when the molten steel is poured from it and, also, to hold the slag which is dumped from the converter after each blow. A safety railing placed around the pit would be a great inconvenience during the operation of the converter. In order to prevent accidents the pit should be covered by a steel plate when the converter is not in use. Fig. 1 shows a cover over the pit in front of the converter at the left. This allows a safe passageway for the men working around the converters.

The operator's booth should be located as near as possible to the converters so that all flame reactions may be clearly observed. The booth should be of fireproof construction and provide protection for the operator. Instruments and levers should be arranged so that all conditions may be watched and controlled from one position. Fig. 2 shows the construction and arrangement of the apparatus in the operator's booth.

Electric Winch Performs Yard Duties

A new type of electric car hauling winch recently was developed by the Shepard Electric Crane & Hoist Co., Montour Falls, N. Y. The operating units of this machine are identical with the units of the electric hoists manufactured by this company. All moving parts are fully enclosed, making the machine entirely weatherproof with the exception of the motor. Oil bath lubrication is provided for all the gearing, brakes, etc. The gearing is of the balanced drive type, driving at two points diametrically opposite in order to insure high efficiency, quietness and safety.

As shown in Fig. 1, the winch is mounted on a cast base which encloses the controller resistance. A standard controller is used and may be mounted directly in the base or separately for remote control. This machine can be furnished with a gear shift, giving a reduction of 4 to 1, enabling the winch

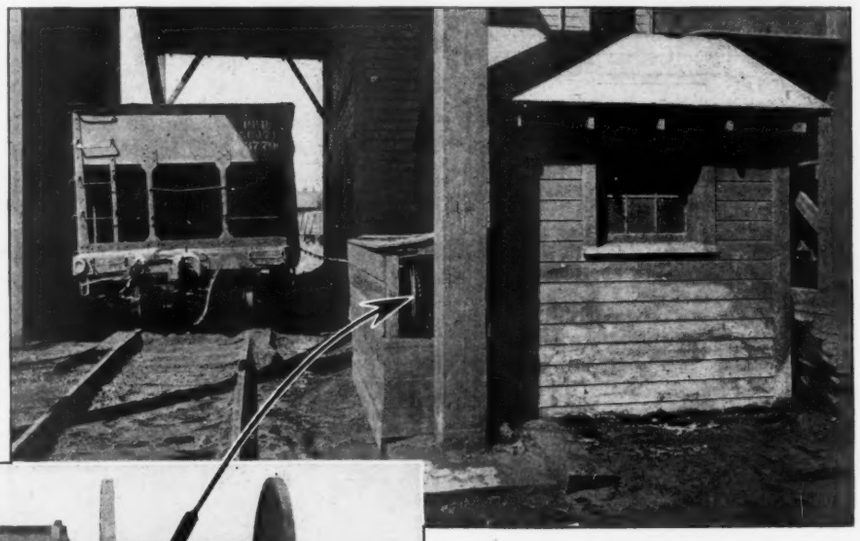


FIG. 2—THE DRUM EXTENDS THROUGH WALL OF WINCH HOUSE

to handle four times the rated load at one-quarter the rated speed.

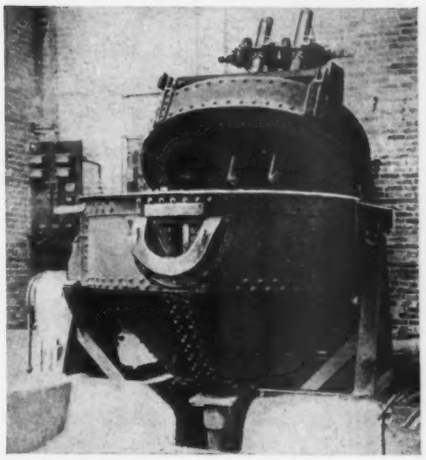
One of these winches recently was installed in the new coaling station of the New York Central railroad at Rensselaer, N. Y., to be used in place of locomotives to draw loaded coal cars up to the coal dump. The winch has a capacity of 4½ tons, a speed of 55 feet per minute and a winding drum capacity of 250 feet of cable. It is driven by a 3-phase, 25-cycle, alternating current, 22-horsepower General Electric motor operating at 700 revolutions per minute. About 200 feet of ⅞-inch wire rope is used.

The machine is installed in a winch house, as shown in Fig. 2, with the drum extending through the side of the building. The cable is attached to a ring in the side of a car. Cars must be pulled up a grade on curved tracks; in a recent test made 14 cars were pulled around the curve and up-grade.

Charles L. Kerr and A. L. Grinnell have opened an office at 505 Garrick building, Chicago, where they will represent the American Fire Clay & Products Co., Cleveland, the Quigley Furnace Specialties Co., New York, and the Columbian Facings Mills Co., Buffalo.

Develops Small Unit

Small electric furnaces fill a need in the foundry for making castings of special composition and for filling small orders for particular castings. Some shops are able to economically produce their own castings with a small furnace, which would not be in position to install a larger furnace. To meet the demand for small furnaces the Industrial Electric Co., Chicago, has designed a new furnace. This furnace is similar to the one described in THE FOUNDRY of Feb. 1, except that it is built for capacities up to 1½ tons and the tilting arrangement is different. The smaller furnace is mounted on trunnions for tilting, as shown in the accompanying illustration. One of the problems in the design of these furnaces is to secure a suitable bottom contact. This is accomplished by an adaptation of the U-type contact.



NEW 1½-TON TILTING ELECTRIC FURNACE FOR LIGHT CASTING WORK

Alexander Huigh, formerly Boston representative for the Whitehead Brothers Co., Providence, R. I., has resigned to enter business as representative of various foundry equipment companies including the George E. Pettinos Co., Philadelphia, of which concern he is New England agent; the National Engineering Co., of Chicago, and the H. C. Mills Co., of Syracuse, N. Y. Mr. Huigh has opened an office in the Massachusetts Trust building, Boston.

What the Foundries Are Doing

Activities of the Iron Steel and Brass Shops

The John B. Morris Foundry Co., Cincinnati, contemplates the erection of an addition to its foundry.

The Industrial Steel Casting Co., Toledo, O., has increased its capital from $100,000 to $150,000.

The Lakeside Foundry Co., Detroit, recently increased its capital from $40,000 to $120,000.

Brown & Boggs Co., Ltd., Hamilton, Ont., contemplates the erection of an addition to its foundry.

The plant of the Palmer Foundry & Machine Co., Palmer, Mass., recently was damaged by fire.

An addition, 30 x 100 feet, will be added to the plant of the Utility Pattern Works, Milwaukee.

The Home Stove Works, Chicago, contemplates the erection of a foundry, 65 x 165 feet.

The Griffith Foundry Co., Griffith, Ind., has increased its capital from $50,000 to $150,000.

Plans are being prepared for the erection of a foundry for the Hull Iron & Steel Works, Hull, Que.

The Philbrick-Booth Foundry Co., Hartford, Conn., recently increased its capital from $20,000 to $70,000.

The plant of the Runnymede Brass Foundry, Toronto, Ont., recently was damaged by fire.

The Buckeye Brass Mfg. Co., Cleveland, is erecting an addition to its foundry.

Work has started on the erection of a plant for the Regle Brass Co., Greenville, Mich.

The capital stock of the Gerline Brass Foundry, Kalamazoo, Mich., recently was increased from $20,000 to $100,000.

Plans are being prepared for the erection of an addition to the plant of the Cherryville Foundry Works, Cherryville, N. C.

The Advance Foundry Co., St. Joseph, Mich., has been incorporated with a capital of $20,000, by William B. Mathieu and others.

The Flint Foundry Co., Flint, Mich., contemplates the erection of additions to its foundry, 70 x 200 feet and 80 x 118 feet. C. E. Boyd is manager.

Plans are being prepared for the erection of an addition to the plant of the Acushnet Iron Foundry, New Bedford, Mass.

The McInnerney Co., Council Bluffs, Iowa, has purchased a site on which it contemplates the erection of a foundry and machine shop.

Plans are being prepared for the erection of a foundry, 160 x 200 feet, for the Sweet Bros. Foundry Co., Johnson City, N. Y.

The Royal Brass Foundry Co., 39 New York avenue, Newark, N. J., has been organized by A. C. Fuchs and others.

Richard Hart has a permit to erect a brass foundry, 20 x 36 feet, at 22 Leonard street, Brantford, Ont.

J. C. Miller, William F. Lange and L. P. Young have organized the Hartford Foundry & Machine Co., at Hartford City, Ind.

The H. A. May Foundry Co., Philadelphia, has purchased property as a site on which to build a new plant.

An addition, 40 x 85 feet, will be erected to the plant of the Charles Jurack Pattern Works, Park and Clinton streets, Milwaukee.

Chalmers & Williams, 72 West Adams street, Chicago, manufacturers of mine equipment and elevator buckets, contemplates the erection of a foundry.

The Arnold Co., Inc., Norwalk, Conn., iron founder, has let a contract for the erection of an addition to its plant, 50 x 100 feet.

The Holmes Foundry Co., Sarnia, Ont., has awarded a contract for the erection of an addition to its plant.

The Sand Mixing Machine Co., Greenfield, O., recently increased its capital stock from $100,000 to $110,000.

The Young & Son Pattern Co., Cleveland, recently was incorporated with a capital of $25,000, by J. H. Watson Jr., M. C. Myers and others.

The Aurora Foundry Co., 375 Spruce street, Aurora, Ill., has started work on the erection of an addition to its plant, 48 x 100 feet.

Plans are being drawn for the erection of a foundry, 38 x 64 feet, for the Chicago Steel & Wire Co., Chicago.

The Johnson Automatic Sealer Co., Battle Creek, Mich., has plans for the erection of a foundry building, 92 x 122 feet.

The General Bronze Foundry Co., Cleveland, has been incorporated with a capital stock of $52,500, by R. H. Jamison, Cuyahoga building, W. R. Daley, F. X. Cull, J. G. Bachman and others.

The Phoenix Iron & Foundry Co., Phoenix, N. Y., recently was incorporated with a capital stock of $25,000, by W. A. Markwick, F. D. McCuen and J. Burns, Syracuse, N. Y.

W. A. Mahoney, architect, 72 Quebec street, Guelph, Ont., has prepared plans for the erection of an addition to the foundry of the T. Eaton Co., 190 Yonge street, Toronto, Ont.

The Phoenix Pattern & Model Mfg. Co., Hartford, Conn., has been incorporated with a capital of $50,000, by G. H. Newman, J. J. O'Connor and F. H. Allen, East Windsor, Conn.

The Solder Improved Stove Co., Biddeford, Me., recently was incorporated with a capital stock of $500,000, by George B. F. Goodwin, James H. Fenderson and John A. Snow.

The New Holland Brass, Bronze & Aluminum Co., New Holland, Pa., has been incorporated with a capital of $120,000, by John A. Hoffman, J. Maurice Smith and John F. May.

The Morris Brass Foundry Co., Racine, Wis., will move its plant to Fond du Lac, Wis., where a building has been purchased and which it will convert for brass and aluminum casting.

The Saco-Lowell Works is going ahead with the erection of a foundry at Biddeford, Me., and has awarded the contract for the construction of the foundation to the Aberthaw Construction Co., Boston.

The Dominion Welding Mfg. Co., 584 St. Timothy street, Montreal, Que., has acquired the plant of the Belanger Foundry Co., 340 Amherst street, and will occupy the premises immediately.

Capitalized at $20,000, the Colonial Foundry & Machine Works, Inc., Boston, recently was chartered by William A. Snow, Thornton A. Snow, Somerville, Mass., and A. L. Ruggles.

The M. D. Jones Foundry Co., Concord, Mass., has been incorporated with a capital stock of $25,000, by Loring N. Fowler, F. G. Jones and Charles H. Murphy, Laconia, N. H.

The Lufkin Foundry & Machine Co., Lufkin, Tex., plans to erect three additions to its plant, two being machine shops, each 50 x 120 feet, and the other a foundry, 50 x 120 feet. N. C. Trout is general manager.

Architect E. B. Funston, Racine, Wis., is taking bids in behalf of the Burlington Brass Works, Burlington, Wis., for the erection of a foundry and machine shop addition, 100 x 140 feet. C. Roy McCanna is president.

The Baker-Perkins Mfg. Corp., New York, recently was incorporated with a capital of $850,000, by S. B. Howard, G. V. Reilly and A. R. Meyers, 65 Cedar

street, to engage in the manufacture of stoves and baking machines.

The Pioneer Brass Works, Indianapolis, recently increased its capital stock from $70,000 to $100,000 to provide additional working capital. The company is contemplating the erection of a new plant, but at present has not definitely decided on the project.

The Evinrude Motor Co., 279-281 Walker street, Milwaukee, has started construction of a new plant of 60,000 square feet of floor space, at Twenty-seventh and Lake streets. The plant is expected to be ready for occupancy about Oct. 1. The company's present factory has been sold.

The Pennsylvania Pump & Compressor Co., Easton, Pa., is making good progress on the erection of its new plant. A railroad spur has been laid and rapid progress is being made in the erection of the first unit of the plant, which is a building, 100 x 200 feet.

A plant will be erected here by the Milwaukee Ice Machine Co., Milwaukee, organized with $500,000 capital a year ago, and which since has conducted its business in leased quarters. A site for the new plant has been purchased and plans are now being prepared for the erection of a gray iron foundry and machine shop.

The Vi Brass & Aluminum Co., Bryan, O., will locate a foundry at Massillon, O., according to a recent announcement by Secretary E. B. Lord of the Massillon chamber of commerce. The company will locate in a building now occupied by the Massillon garage. Operations are expected to begin the early part of May. C. H. Noll of Bryan, is president, and M. V. Crayon will manage the business.

The Hanson Clutch & Machinery Co., Tiffin, O., has recently increased its capitalization from $60,000 to $300,000, and is now erecting a large addition to its plant. The company will install the most modern type of machine tools, and at present is contemplating greatly enlarging the capacity of its foundry. This company, which manufactures friction clutches, has sold more than 40,000 clutches since it was organized four years ago.

Organized originally to make war munitions, the G. W. MacFarland Engineering Co., Ltd., Paris, Ont., has recently reorganized and will utilize its present floor space, approximating 85,000 square feet, for a gray iron foundry. It plans to manufacture a complete line of foundry equipment in addition to gas engines. While it has considerable equipment on its hand from its war work, the company will require additional machinery. These requirements are now being listed and will be made known shortly.

New interests have acquired the Covington Machine Co., Inc., Covington, Va., founder and machinist. The plant has a well equipped machine shop and foundry. It manufactures coal leveling and coke drawing and loading machines for beehive ovens; punches, shears, bending rolls and other equipment. The foundry produces small brass castings, gray-iron castings weighing up to 20 tons. The new officers are: President, F. U. Humbert; vice president, F. W. King; secretary and treasurer, G. W. Lipscomb and manager, E. H. Archer.

Specializing in pistons, piston pins and cast iron head valves and other automotive parts, the Powelson Foundry & Machine Co., Inc., 304-320 Franklin street, Rochester, N. Y., recently was organized with a capital of $200,000. It has purchased the foundry and equipment of Josiah Anstice & Co., and has placed orders for machine shop equipment. Officers are: President and general manager, J. W. Powelson, recently works manager for the Pittsburgh Model Engine Co.; vice president and treasurer, F. C. Kimmel, recently president and general manager of the Rochester Motors Co., Inc., Rochester, N. Y.

Gray iron and semisteel castings will be produced by the North Milwaukee Foundry Co., North Milwaukee, Wis., recently incorporated with a capital of $40,000. It has purchased some buildings on a 2-acre site on the Chicago, Milwaukee & St. Paul railway and has completed an addition to the foundry building, 50 x 80 feet. Later the company intends to make extensive additions to the plant and at that time will increase its capital. At present its capacity will be from 10 to 15 tons of castings daily. Joseph Ewens, formerly president of the Hercules Steel Castings Co., Milwaukee, is president and general manager; Dr. M. N. Federspiel is vice president and C. G. Johnson is secretary and treasurer. Herman Dehn, who for many years has been in charge of various gray iron foundries in Milwaukee, will be foundry superintendent.

Ground was broken recently at Beloit, Wis., for a new gray iron foundry group for Fairbanks, Morse & Co., Chicago. The plant is expected to be ready for occupation by Nov. 1, and will provide a casting capacity of 500 tons, with four cupolas operating alternately in tandem. The main shop will be 450 x 550 feet, and the pattern shop, 80 x 230 feet, 4-stories high. The foundry is laid out for a second unit to be erected later, making the complete shop, 550 x 900 feet. The equipment includes 24 electric cranes, of five to 45 tons capacity, which will handle all material, including sand, scrap, pig iron, etc. Castings will be transferred to the various machine shops on standard gage cars in trains of 10 cars each, hauled by three electric locomotives. The present foundry and pattern shop is to be converted into a machine and assembling room. George B. Ingersoll is general manager.

New Trade Publications

GRINDING WHEELS.—Norton Co., Worcester, Mass., has published a 14-page illustrated booklet in which a grinding wheel stand for use in machine shops is described and illustrated. This machine is built in two types and styles.

OIL BURNER OUTFITS.—The Macleod Co., Cincinnati, has published an illustrated booklet in which oil burner outfits and rivet forges, for use in railroad and car shops, boiler shops, shipyards, on structural iron work, etc., are described and illustrated.

WELDING TORCHES.—The Air Reduction Sales Co., New York, has issued a new catalog describing its line of welding torches. The booklet is complete and gives a clear understanding of the principles of torch operation. It is well illustrated with halftone reproductions of the various torches, angles and heads, tips, etc. Tables are given showing the thicknesses of metal that can be welded by the various tips supplied with each torch, and in addition pressures required, speed of welding in feet per hour, gas consumption in cubic feet per hour, etc., are given.

PNEUMATIC HOIST.—Pneumatic motor hoists are described and illustrated in a booklet recently published by the Independent Pneumatic Tool Co., Chicago. A general description of these hoists and instructions as to their assembling are given. The hoists are equipped with large worm gear drive; the speed of the motor is controlled by a throttle valve and may be reversed by shifting the eccentric, which is done by throttle chains while the throttle valve is shut off; cables and drums are placed far apart; the motors are equipped with oil gages as are the hoists proper; one-half of the worm gear is constantly immersed in oil.

HEATING FURNACES.—A booklet entitled, "Design and Operation of Heating Furnaces," has been published by the Under-Feed Stoker Co. of America, Detroit, and is being circulated to the trade. The booklet contains authoritative data on the everyday working of industrial furnaces, and the matter is prepared in such a way that not only technical engineers but those possessing but a general knowledge of the subject will be interested, due to the fact much technical detail has been avoided. The bulletin is divided into four parts dealing with the most important factors. They are: Combustion of coal; theory of heat; furnace design; stoker application and waste heat boilers.

SANDBLAST BARRELS.—The Standard Equipment Co., New Haven, Conn., recently published an 8-page booklet in which radial blast sandblast barrels are described and illustrated. In the operation of these barrels, according to the booklet, the abrasive automatically returns to the sand chambers which feed the sand nozzles. The nozzles operate from 8 to 10 inches from the work and the air nozzles are so arranged that nothing but air passes through them. All rolls, gears, etc., are outside the blast. Neither hopper nor nozzles project inside the barrel. In operation, these barrels turn slowly from left to right and as soon as one set of nozzles arrive in position ready to blast, the air is automatically turned on to this set until as it passes below the level of the work, when it is cut off and turned into the second set, which by this time is in position to blast.

TROLLEY CARRIER.—A well designed and profusely illustrated booklet of 24 pages has been issued by the American Steam Conveyor Corp., Chicago and New York, describing its trolley carrier for handling coal, ashes and other bulk material. A typical installation is shown by which coal is unloaded from cars and discharged into a shallow hopper whence it is elevated by bucket either to bunkers, an open stock pile or to a truck. Ashes are conveyed from the plant to any desired point. Special types of hoists, trolleys and buckets are also described, as well as steel structures for carrying either the monorail or suspended cable type of carrier. Interesting sketches of various applications of the trolley carrier are presented.

HEAT TREATMENT.—A pamphlet entitled "The Hump Method for the Heat Treatment of Steel," has been issued by the Leeds & Northrup Co., Philadelphia, and in it a new method of hardening steel is described. Accurate measurement of temperatures and the independent determination of transformation points are rendered unnecessary with this method, according to the booklet. The work is heated in an electric furnace in contact with or near, a thermocouple. A recording instrument draws upon a large scale chart a curve of the electromotive force developed by the thermocouple. While the work is passing through the transformation or decalescence point, the rise in temperature is arrested producing a jog or "hump" in the line. The operator allows the work to remain in the furnace a definite number of minutes after this jog appears and then quenches. The results claimed are entire uniformity of heat treatment, including grain size, hardness and tensile strength, with freedom from distortion, breakage, decarbonization and scale.

FOUNDRY INSTRUCTION:—An interesting booklet has been prepared by McLain's System, Inc., Goldsmith building, Milwaukee, directing attention to and furnishing a synopsis of the course of instruction on iron and steel foundry practice which has been developed by Mr. McLain, the head of the institution. According to the pamphlet two courses of instruction are available: one on gray iron, semi-steel and cupola practice and the other on steel foundry practice covering all processes. The first course is covered by a series of 12 lessons, approximately 500 pages 8½ x 5 inches; while the second is treated in eight standard lessons. Each chapter or lesson in the course is described and the prospective student told exactly what points are covered. The editions include: Composition of iron; grades of iron, coke and scrap for different castings; mixing by analysis; how to make savings; general foundry practice; physical and chemical analyses of high explosive shells; chill castings; cupola practice; McLain's semi-steel. The course on steel foundry practice embraces: Materials; sand mixtures; gates and risers; and acid and basic melting. Besides a synopsis of the course of instruction offered by the institution, the pamphlet contains many pertinent hints for the foundryman.